BEFORE THE
FEDERAL-STATE WATER RESOURCES
COMMISSION
and
JOINT LEGISLATIVE COMMITTEE ON
STATE WATER RESOURCES,
State of California.

The San Joaquin Valley

in the

STATE-WIDE WATER PROBLEM

of California

A Brief Presented on Behalf of the
San Joaquin Valley,
by the
San Joaquin Valley Water Committee.

To the Members of the Federal-State Water Resources Commission and Joint Legislative Committee for Investigation of the Water Problems of California.

1.—INTRODUCTION:

The San Joaquin Valley, 250 miles long, and 40 miles wide, comprising the largest continuous block of agricultural land in the State of California, respectfully presents to you herein a Brief on the most vital problem now confronting it—its need for a sufficient supply of water to maintain its present developed areas, and assure an orderly development as economic conditions justify, of those areas within its borders not now developed, but worthy of development in the future.

The San Joaquin Valley has within it, one-third of all the agricultural land in the state. One-half the lands now under irrigation in California are in the San Joaquin Valley. Less than half of that irrigated area now has an adequate water supply. In great areas in the southern half of the valley, whole communities which by their assessed valuation show a greater investment in rural improvements than any other section of the state excepting properties adjacent to our largest cities, are literally threatened with extinction unless water be brought to them from distant sources.

This water shortage in the San Joaquin Valley is now so serious that it should be the concern not only of the State of California but of the United States. It comprises a major, and we think the most pressing element of the state-wide water problem in California.

This Brief is primarily an appeal for the aid of both the United States and the State of California to the San Joaquin Valley for the permanent solution of its water problem; but it is also an effort to contribute additional facts and suggestions which may help to decide the best method of that solution. It is presented by the San Joaquin Valley Water Committee, representing all of the eight counties in the Valley, San Joaquin, Stanislaus, Merced, Madera, Fresno, Tulare, Kings and Kern.

2.—AUTHORITY FOR BRIEF:

Shortly after the adjournment of the 1929 Session of the Legislature of California, a mass-meeting was held at Fresno, California, to consider the water problems of the San Joaquin Valley and their relation to a state-wide plan of water development. This meeting was well attended by representative citizens from all of the eight counties of the Valley. By resolution, unanimously adopted, it authorized the organization of a San Joaquin Valley Water Committee composed of three members from each of the eight counties, and authorized said committee to speak for and represent the San Joaquin Valley in the matter of a co-ordinated state-wide water plan. The Committee was duly chosen and organized, and has actively functioned ever since July, 1929.

Its membership is as follows:

San Joaquin County:
Oscar L. Mars, Lodi Cal.
C. E. Steinegul, Escalon, Cal.
John Perry, Stockton, Cal.

Stanislaus County:
R. V. Meikle, Turlock, Cal.
W. W. Cox, Westley, Cal.
V. D. Whitmore, Ceres, Cal.

Merced County:
D. K. Barnell, Merced, Cal.
W. E. Bunker, Gustine, Cal.
H. C. Cronkite, Merced, Cal.

Madera County:
W. S. Hillis, Madera, Cal.
John Holliday, Madera, Cal.
George Mordecai, Madera, Cal.

Fresno County:
Chester H. Warlow, Fresno, Cal.
A. B. Tarpey, Clovis, Cal.
W. A. Collins, Fresno, Cal.

Tulare County:
J. T. Crowe, Tulare, Cal.
James M. Burke, Visalia, Cal.
F. M. Pfrimmer, Porterville, Cal.

Kings County:
G. H. Phillips, Hanford, Cal.
Roy L. May, Hanford, Cal.
W. W. Sheahan, Lemoore, Cal.

Kern County:
C. A. Melcher, McFarland, Cal.
J. H. McMillen, Wasco, Cal.
A. S. Jewett, Bakersfield, Cal.

The officers of the Committee are Chester H. Warlow, Chairman; James M. Burke, Vice-Chairman; and M. P. Lohse, Secretary. Its offices are in the Chamber of Commerce Building, Fresno, Cal.

Thus organized, and authorized, the San Joaquin Valley Water Committee respectfully presents this Brief on behalf of the San Joaquin Valley.

3.—GENERAL PRINCIPLES:

The San Joaquin Valley Water Committee, after careful consideration, adopted a declaration of general principles. In this declaration the attitude of the San Joaquin Valley on several of the most vital points in any state-wide water plan is expressed, and therefore the Declaration of Principles is here set forth in full.

1. We favor the adoption at one time by the State of California of a complete state-wide plan sufficient in scope for the ultimate conservation and economical use of all the waters of the state, provided such a plan can be so developed as to be just and equitable to all portions of the state. If under the state-wide plan, State money is expended to provide irrigation or reclamation work for certain areas, then those areas which have provided similar facilities at their own cost, should be assisted by the State to an equitable extent. The units of the plan should be constructed from time to time as the need for additional water becomes sufficiently urgent.

2. It should be the policy of the state in carrying out such plan to construct first the units which will provide an ample supply of water to those areas which are already under irrigation, by pumping or gravity water, but which have an insufficient supply available, provided, however, that each unit should be constructed with the view of coordinating with the complete plan.

3. a—Of the waters within the Sacramento River drainage basin, and all other drainage basins, a sufficient quantity should be reserved to those drainage basins for the ultimate and complete irrigation of all the tillable lands susceptible to irrigation lying within the natural drainage basin of that particular stream, or lying adjacent to that stream and conveniently irrigable therefrom, except in so far as such waters shall have been fully and equitably replaced by waters exchanged from other streams.

b—In any exchange of waters, the water rights then existing or in process of acquisition. and all other vested interests should be fully protected.

c—The right to acquire water by exchange should be dependent and contingent upon actual delivery of lieu water of equal quality and quantity to the persons entitled to the original stream flow.

d—The right to lieu water should be commensurate with the right to the water taken as it exists at the time of the exchange.

4. It should be the policy of the State that a thorough investigation be made, and consideration be given to the possibility of an adequate gravity system extending to the south end of the San Joaquin Valley and including the whole of said valley.

5. If the plan to pump water up the San Joaquin River is adopted, provision should be made for ample drainage of all areas which will be affected by seepage and backwater caused thereby; and also for the disposal of all drainage waters which now go into the San Joaquin River.

6. Feasible utilization of all local sources of water for local needs should be an inherent part of the general plan; and importation of water from other sources should not be undertaken except where necessary to supplement the local supply.

Particular attention is directed to Paragraph 3a of this Declaration of Principles. The San Joaquin Valley reaffirms in the most solemn manner its adherence to the proposition that the waters naturally flowing in any given section or locality of the state, belong first to that section or locality to the full extent necessary for its complete development and maintenance; and the San Joaquin Valley neither asks nor expects that any water be allowed or taken to it from any other section of the state, except from such surplus as is first demonstrated to exist over and above the full ultimate needs of the section from which said waters are taken.

4.—SCOPE OF BRIEF:

The scope and purpose of this Brief may be stated as follows:

(a) To present generally as to each of the Valley counties, the present situation as to water resources and water development.

(b) To emphasize the desperate need of great areas in the southern half of the Valley for more water if even their present development is to be preserved.

(c) To supplement the vast amount of information already gathered by the State Engineer, with such additional special facts and illustrations as may be helpful to this Commission and to the Joint Legislative Committee.

(d) To discuss so far as seems proper, some of the financial and economic phases of the importation of an additional water supply into the Southern San Joaquin Valley.

(e) To direct attention to some special or local problems in the Valley which may arise in connection with the development of a general plan for the relief of the San Joaquin Valley.

5.—CLASSIFICATION OF COUNTIES:

Owing to differences in their developed and potential water supply, and differences in their location, the eight counties of the San Joaquin Valley fall naturally for purposes of this discussion, into two divisions, the Southern counties and the Northern counties.

The Southern counties are those in which there is a present and growing shortage of local water supply. They are the Counties of Fresno, Tulare, Kings and Kern.

The Northern Counties are those which have a potential or developed local water supply fairly adequate for their present needs and in most cases for their future develop-

ment. These counties have however problems of grave interest to them in connection with the proposed State-wide Water Plan, which problems are touched upon in this Brief. They are the counties of San Joaquin, Stanislaus, Merced and Madera.

6—SOUTHERN COUNTIES AS A WHOLE:

It is not an exaggeration to say that in fertility of soil, favorable climatic conditions, and diversity of products, the four southern counties of the San Joaquin Valley constitute one of the greatest agricultural regions of the world. Their only lack is an adequate water supply. The following consolidated statistics for the four counties of Fresno, Tulare, Kings and Kern are gathered from authoritative sources and are presented to indicate the importance of these counties to the nation and the state:

Population (1930 census) 326,928.

Assessed Valuation, last fiscal year, $528,329,138.00.

Value of Farm Products sold in 1929, including cattle and hogs, dairy products and poultry $133,212,740.00.

These figures of enormous agricultural wealth and productive power would seem at first to contradict the assertion of threatened disaster from water shortage.

The fact is however that the tremendous development evidenced by these statistics is in large part the result of an ever-increasing over-draft on the water supply of the area. Two factors of supreme importance are responsible for the development, and, strangely enough, they are now the very factors which threaten the disaster. These factors are:

(a) The fact that by an infinitely slow process through the ages, Nature stored an enormous quantity of water beneath the surface of the vast alluvial deposit making up the great valley fill in these four counties.

(b) The development of hydro-electric energy in the near-by mountains, with transmission lines making it possible with cheap electricity to pump this underground water as a supplement to the deficient supply of the surface streams.

To indicate the tremendous growth in electrical pumping in the four Southern Counties, the records for the past six years of the two power companies supplying electricity in them have been carefully tabulated and the result is presented in the following table:

TABLE SHOWING DEVELOPMENT OF ELECTRICAL PUMPING FOR AGRICULTURE IN FOUR SOUTHERN COUNTIES OF SAN JOAQUIN VALLEY

	No. Consumrs	Horse Power	Kilowatt Hrs. Used
FRESNO COUNTY:			
1924	2,168	23,638	23,604,254
1925	2,794	31,144	38,557,300
1926	3,993	43,971	64,244,000
1927	5,052	51,391	52,138,900
1928	5,516	59,394	81,436,900
1929	6,616	69,621	91,365,000
KINGS COUNTY:			
1924	666	8,396	18,400,000
1925	818	10,968	23,525,000
1926	988	14,252	33,430,000
1927	1,054	16,582	25,425,000
1928	1,106	17,484	41,305,809
1929	1,337	24,875	57,257,926

TULARE COUNTY:

1924	5,042	48,911	105,795,190
1925	5,766	59,432	113,468,983
1926	6,564	71,404	135,993,200
1927	6,888	74,462	117,822,990
1928	7,172	80,233	163,613,632
1929	7,705	91,666	178,454,073

KERN COUNTY:

1924	1,500	22,606	54,940,417
1925	1,709	27,848	64,326,975
1926	1,788	29,905	70,017,934
1927	1,875	31,055	59,212,816
1928	1,857	33,467	68,914,271
1929	1,994	37,388	79,287,655

Up to a certain point the two factors, abundant underground water close to the surface, and abundant cheap electric energy, made possible within the past twenty years, a great agricultural development and sustained it, no matter how deficient the annual rain fall or stream run-off. Indisputable facts now show however that that point has been reached and far exceeded. The annual draft on the underground water supply now exceeds and has for several years exceeded any possible replenishment of that supply. The supply from the surface streams is utilized more completely than in any other area of the state. There can be but one result and that result is now in plain sight. Steadily falling levels in the underground basin, vast expenditures by landowners in deepening wells and installing enlarged pumping equipment in their endeavor to maintain their crops, and finally in ever widening areas, the reaching of an economic limit where further efforts cease and farms are abandoned, are facts now existent in the Southern San Joaquin Valley Counties. They are more acute and more tragic now in some areas than in others because of diversity in local water conditions; but their import is all too plain, and they point to but one conclusion. The present agricultural development of these counties cannot be maintained, and no sustained future development is possible unless additional water in great quantity is imported into these counties as soon as possible from regions having a water surplus. We propose now to point out the salient facts which make this conclusion perfectly plain, proceeding generally along the following lines:

(a) The annual requirement of water reasonably necessary to maintain present development; with consideration also of requirement for future development.

(b) The average annual supply in the area, and its utilization.

(c) The difference between annual supply and annual requirement, resulting in overdraft on the underground water resource.

(d) Falling levels and failure in underground supply resulting from this over-draft.

(e) Resultant constant increase in cost of obtaining a lessening water supply, which approaches, and in places has reached the economic limit forcing the abandonment of fertile developed farms.

7.—SOUTHERN COUNTIES, WATER SUPPLY AND WATER DEMAND AS A WHOLE:

Experience and extended investigation has demonstrated one vitally important fact as

to water supply in this area. There is no mysterious source of replenishment of the ground water. It's sole source is run-off from the locally tributary drainage areas. As this run-off, except for minor amounts coming from the lower hill areas, occurs in definite stream channels in which it can be, and has been measured for years, those measurements enable the average annual water supply both surface and underground of these four counties to be determined, and it has been determined within a very narrow margin of uncertainty. A compilation of the total average annual run-off of all streams between the north line of Fresno County and the South line of Kern County taken from Bulletin No. 11 of the Department of Public Works, prepared by Mr. S. T. Harding, shows an average annual supply for the four counties of 3,235,800 acre feet. Bulletin No. 11 was issued in 1927. It was prepared in 1926, and stream-flow records in it ended with the year 1925.

Careful measurements and compilations brought to the close of 1929, show that the average annual run-off i nthis area for the ten years commencing with 1929, was 2,419,300 acre feet. For the five years commencing with 1924, the average annual run-off was 2,256,000 acre feet.

Turning now to the demand on that supply to maintain present development, a compilation of all records available shows at least 1,750,000 acres of irrigated lands. On an average annual run-off in this area for the ten years commencing with 1919, was 2,419,300 total demand for present devlopment is 4,375,000 acre feet.

A duty of 2½ acre feet per acre per year is admittedly a low estimate. Alfalfa, cotton and many other crops grown on thousands of acres of these valley lands require much more. For them, an average of 3½ of 4 acre feet per acre per year would be more nearly correct. But, assuming an average duty of 2½ acre feet per annum per year, and assuming that every drop of available water were brought to the land, the shortage in annual supply as compared with demand is from 1,140,000 acre feet to 2,119,000 acre feet. Of course all the water cannot be and is not brought to the land. There are losses from evaporation and other unavoidable causes, and too there are the demands for human and animal consumption and other uses exclusive of irrigation. For these losses and these other uses, an estimate of 20 per cent of the total supply is conservative. Applying this percentage, we have an annual shortage in the amount necessary to maintain present development, based on a 2½ acre feet per acre duty of water, of from 1,786,360 to 2,570,000 acre feet. The latter figure is, as later details herein will show, a conservative figure for the actual amount by which the average supply now falls short every year of the amount required to maintain present developed agricultural lands. That shortage has been for several years past and is now being made up by an over-draft on the underground water supply which Nature stored in ages past. It needs but little imagination to picture what is happening to that underground supply, and what will happen to the orchards, the vineyard, grain, alfalfa and cotton now dependent upon it, when this tremendous annual draft finally exhausts the store. Not less than five hundred thousand acres now flourishing and producing all manner of crops, will revert to scanty pasture or desert, and the human tragedy which will be involved in the destruction of thousands of now prosperous homes beggars description. It is to avert this disaster that the Southern San Joaquin Valley calls now to the nation and to the state for aid.

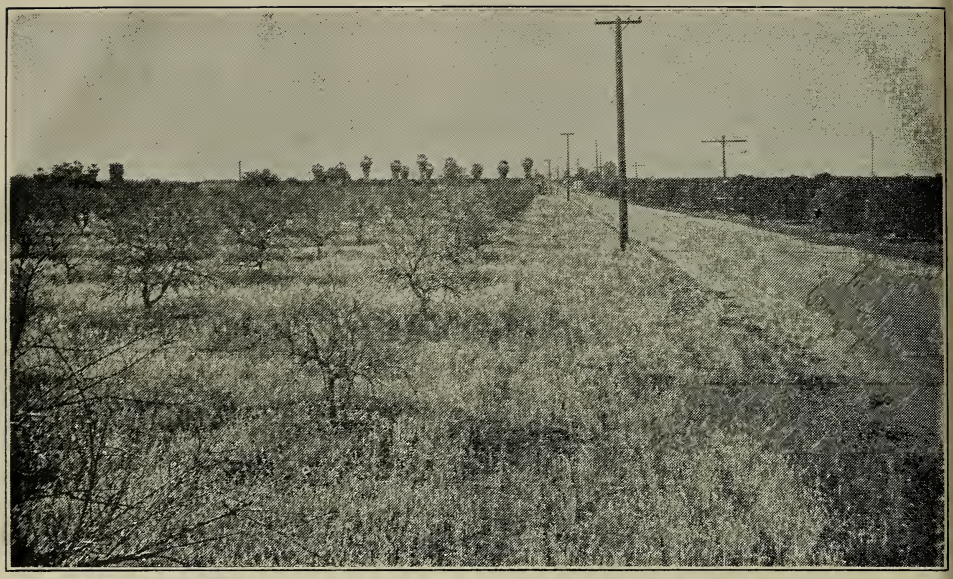
Orange Orchard Abandoned for Lack of Water

8—SOUTHERN COUNTIES SEPARATELY. TULARE COUNTY:

Necessarily, over so great an area as the four Southern San Joaquin Counties, there are great local variations as to water supply. It varies in different localities depending on their proximity to the larger surface streams. For this reason a comparison of the average total supply for the four counties with the total draft, does not present the entire picture. It is necessary to deal with each county separately. We commence with Tulare County and deal with it more elaborately than with any of the other counties for two reasons, first because investigations have been more exhaustive and complete in that county than in any other, and secondly because the emergency of the situation is in some respects more apparent in that county than in any of the other three. It is fair to say however that while to some degree the other three counties may just now be better off than Tulare County, it is simply a difference of degree and not of kind, for situations have already developed in each of the other three counties, similar to the more general situation in Tulare County. If, therefore, we describe the Tulare County situation and some of the more critical situations in the adjacent counties, the picture will fairly present what is happening in greater or less degree to the entire Southern San Joaquin Valley, and what will happen to it in the near future.

8.—TULARE COUNTY:

The condition and trend in Tulare County revealed by the detailed study in the Appendix, is in general true of all the other three Southern Counties. In every one of them, a casual examination discloses the same story of deficient surface supply, falling water levels, tremendous increase in power consumption and irrigation costs, and approach in various areas to the limit where the effort to maintain present development must be abandoned.



Another Abandoned Orange Orchard

Tulare County receives its water supply from four sources, which with their average annual run-off for the past seven years avainable to Tulare County are as follows:

Kings River, Diversion for Alta Irrigation District lying in Tulare County	103,000 acre feet
Kaweah River (less use in Kings County)	284,125 acre feet
Tule River	81,000 acre feet
Deer Creek	11,000 acre feet
Total	489,000 acre feet

A very carefully made and complete crop survey of Tulare County in 1929, shows 316,943 acres under irrigation in the county, and dependent on this water supply. Allowing 20 per cent of the total water supply for domestic consumption, municipal uses, and unavoidable losses, there is an average of 325,200 acre feet of water available for this land. Calculating the annual water requirement for alfalfa, cotton and field crops at 3 acre feet per acre, and for other crops at 2½ acre feet per acre, there is an annual shortage of water necessary to maintain only the present development in Tulare County of 500,000 acre feet.

Mr. C. H. Holley, Engineer for the Tulare County Water Commission, who has been almost exclusively engaged in studying the water situation in the county for several years past, estimated the actual shortage in 1928 at 520,300 acre feet, distributed in different aceas as follows:

TABLE—SUMMARY OF IRRIGATION IN TULARE COUNTY AND DEFICIENCY OF SUPPLY BASED ON AVERAGES FOR PERIOD 1924-1928

Name of Area	Gross Acres	Acres Irrigated	Deficiency of Supply in Ac. Ft.
(1) Alta Irrigation District	95,000	55,000	85,000
(2) Foothill Irrigation District	25,000	9,000	20,000
(3) South of Alta Dist. to Kaweah River	75,000	20,850	16,500
(4) Kaweah River Delta	209,000	84,000	105,000
(5) Tule River Delta	109,000	32,600	55,000
(6) Between Kaweah and Tule River Deltas	117,000	50,300	88,000
(7) South of Tule River	328,000	55,850	150,800
Totals	985,000	307,600	520,300

In 1929, it is estimated the actual shortage was approximately 10 per cent in excess of this, or a total of 575,000 acre feet. This is based solely on the requirements of present irrigated lands, and is exclusive of domestic uses, municipal supply, and unavoidable losses.

Another method of determining the annual deficiency has been followed. The average annual lowering in all areas of Tulare County south of Alta Irrigation District and a small portion of northern Kern County has been determined for five years past. Well recognized factors of porosity have been applied and from this it has been determined that in the five years immediately past, an average of 408,850 acre feet of water *in excess of replenishment* has been withdrawn from the ground water storage in this part of Tulare and Kern Counties every year since 1925. Add an approximate annual deficiency of 100,000 acre feet for the Alta District and Foothill District in Tulare County, and we have again a demonstration that there is an annual shortage of over 500,000 acres feet in the water supply required to maintain present agricultural development in Tulare County.

That annual shortage has been made up and is being made up by overdraft on the underground water supply.

The calculation made by Mr. Holley as above, reveals that Tulare County has in the last five years depleted its underground water supply a total of over 2,000,000 acre feet. In other words, to maintain its present development, Tulare County has in the last five years used every drop of its surface flow, and pumped from its underground supply approximately 500,000 acre feet of water every year more than the replenishment of that underground supply.

Tulare County has in it 633,486 acres of No. 1 land and 190,834 acres of No. 2 land according to the recent state land classification. Of this only about 40 per cent is now irrigated and yet the shortage of water is as above set forth. For full development Tulare County would require not less than 1,500,000 acre feet of water imported into it. Tulare County of course does not ask that now. It asks for relief now to maintain its present development, with whatever reasonable provision is found possible for future growth.

The detailed study presented in the Appendix to this Brief as to Tulare County con-

Water Shortage Forced Entire Tbandonment

clusively demonstrates the accuracy of the statements here made. It reveals further the consequences of water shortage in that County which consequences are already apparent. Some of them are:

(a) Immense economic loss by increased cost of pumping water.
(b) Approach to limit where farming is no longer possible owing to such increased cost.
(c) Abandonment of developed farms.

The reproductions from photographs in this Brief are of developed orchards and vineyards actually abandoned in Tulare County because of lack of water to maintain them. That tragic process has only commenced but is sure to continue in ever increasing magnitude unless relief is obtained.

Here again we emphasize that what is shown of general conditions in Tulare County applies generally to the other three Southern Counties.

We can not close as to Tulare County, without presenting the following statistics concerning it:

Population (1930 census), 75,740.
Population (1920 census), 59,031.
Total assessed valuation, $97,254,548.00.
Sale value of 1929 agricultural products, including cattle, hogs, wool, dairy products, poultry and poultry products, $35,664,520.00.
Number of farms (estimated), 8,000.
Total acreage No. 1 lands (State classification), 633,486.
Total acreage No. 2 lands (State classification), 190,834.
Total enrollment in public schools, 22,430.

Average annual rainfall varies from 6 to 11 inches, depending on locality.

The wealth and annual productive power of this great county evidenced by the foregoing figures will in large part be lost unless relief b yway of an additional supply of water is afforded to it. We think thta we have herein abundantly demonstrated that this great disaster now actually threatens Tulare County, and certainly the situation is such, in view of the threatened loss and destruction of property, as well as the human suffering that will be involved, to call for not only the interest and concern of the remainder of the state but of the nation itself.

As an Appendix to this Brief we present in detail the results of the careful study and exhaustive investigation as to water conditions in Tulare County which has been in progress for several years past, the principal work having been by C. H. Holley, now Engineer for Tulare County Water Commission.

9.—KERN COUNTY:

The major, and practically the only source of water supply for Kern County is the Kern River. Caliente Creek furnishes some water to the area south and east of Bakersfield but is extremely unreliable, and in recent years its surface flow has scarcely reached the valley floor. Mr. Harding in Bulletin 11 estimated its run-off at an annual average of 35,000 acre feet, but this would seem somewhat high. In seasons of heavy rainfall, Poso Creek furnishes some water to the area north of Bakersfield and possibly to the area around Wasco, Shafter and McFarland. Its contribution is, however, very minor. Rag Gulch and a few such inconsequential torrential creeks as flow for a brief time in seasons of extraordinary rainfall are of no consequence.

The average annual run-off of Kern River for 20 years ending with 1929 was 691,100 acre feet; for 10 years ending in 1929 it was 504,600 acre feet, and for 5 years ending in 1929, it was 465,500 acre feet.

The agricultural lands of Kern County are very extensively devoted to alfalfa, cotton and other field crops requiring large amounts of water, and the Kern County Water Commission estimates the average annual water requirement in the county at 4 acre feet per acre per year.

There are approximately 375,000 acres of land now under irrigation in Kern County, and, based on the water requirement above given, the shortage of water for the maintenance of this developed area amounts to at least 700,000 acre feet per year.

As in Tulare County, this shortage has, so far as it is possible been made up in recent years by over draft on the underground water supply. The increase in this pumping draft from year to year is shown by the table previously given showing the growth in use of electricity for pumping in the four Southern Counties.

Except where the immediate influence of Kern River and the diversions therefrom sustain the ground water levels, the same story of falling water levels applies to Kern County as to Tulare County. Vast areas of fertile developed lands are now supported almost entirely from pumping, and in some of the areas there is little or no replenishment of the underground supply.

The farmers in these areas have made and are making a brave and consistent fight to preserve their holdings against this condition, but unless relief comes to them by the importation of water, the end is in sight for many of them.

Kern County is less favored in rainfall than any of the other Valley counties, the average annual rainfall being approximately six inches.

Kern County has a great source of wealth in oil production, but its agricultural resources are enormous. The recent state classification of lands places within its borders 750,000 acres of No. 1 lands and 125,000 acres of No. 2 lands. The market sale value of agricultural products of Kern County for 1929, exclusive of dairy products, cattle, hogs and other livestock and poultry and poultry products for 1929, was over $20,000,000.00, and the addition of the sales of livestock, dairy products and poultry products would bring the total close to $40,000,000.00.

The place which Kern County occupies in the economic life of California is indicated by the following statistics:

Population, 80,000.
Assessed valuation (4th in California), $196,420,700.00.
School attendance, 17,500.
Outstanding County bonds, $1,125,000.00.
Outstanding Municipal bonds, $1,000,000.00.
Outstanding School bonds, $1,686,000.00.

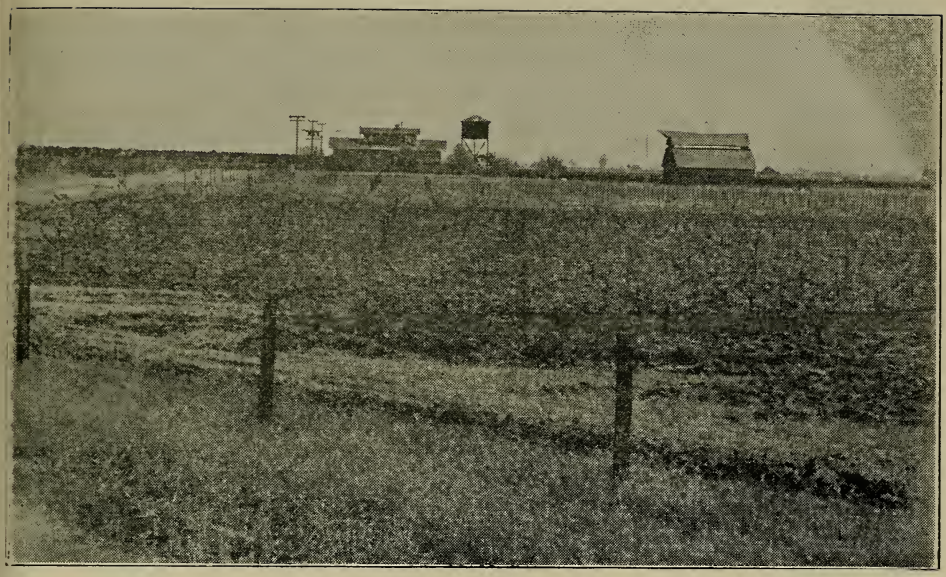
There are no irrigation districts in Kern County, surface waters for irrigation being distributed entirely by private corporations.

10.—FRESNO COUNTY:

In some areas and in some respects owing to the supply furnished by Kings River, Fresno County is in a better condition as to water supply than any of the other three Southern Valley Counties, but it has also the greatest developed acreage and an analysis of water supply and requirement for agricultural uses, the requirement being on a very conservative basis, reveals a tremendous shortage in surface water supply, and the electrical pumping statistics disclose again the same effort to make up this shortage by continuous overdraft in many areas on the underground supply.

Mr. George L. Swendsen, Chief Engineer of Fresno Irrigation District,has prepared a statement as to the water resources and water requirements of Fresno County which we adopt and here set forth in full, as follows:

> "Within the irrigation districts and areas here listed and situate in Fresno County only, there are 823,122 acres of land equipped and organized to properly distribute irrigation water. An analysis of water requirements for this area indicates the need of a supply averaging 2.26 acre feet per acre. It will be appreciated that this average is derived from units of application which vary greatly with soil conditions, crops, situation and terrain. Accordingly, there is need for 1,863,700 acre feet of water annually to adequately serve this area. From Kings River, the San Joaquin River and certain pumping areas there has been secured for this Fresno County area an average during the past eight years of 1,068,900 acre feet



Entire Property Abandoned for Lack of Water

annually, leaving a deficiency of supply amounting to 794,800 acre feet per year. This is the amount of water it is hoped the State Irrigation Plan will make initially available to Fresno County. The works and organization necessary to properly and efficiently distribute the water will be immediately available with the supply and the areas affected will be able to pay a reasonable charge for the water secured.

Districts
Consolidated
Alta
Fresno
Tranquillity
James
Riverdale
Laguna
Foothill
Stinson
Mendota
Crescent
Burrell Area
Murphy Slough
Liberty Area

Developed Areas Outside Specified Districts
Centerville Bottoms
San Joaquin & Kings River Irrigation Canal Co.
Firebaugh Pump Area
Total Acreage, 823,122.
Water Demand, Acre Feet per year 1,863,700
Water Supply, Average 1921-29 incl. Acre Feet per year 1,068,900
Deficiency of Supply, Acre Feet per year 794,800

Should it be desirable to consider the possibility of furnishing water for the ultimate possible development of Fresno County's arable and irrigable land, we believe a reasonably accurate estimate of the water supply necessary can be secured from information in the above summary coupled with data from the State Engineer's San Joaquin Valley Land Classification.

The State Engineer's classification of lands, which has been approved by all the interested authorities in Fresno County, places 1,360,650 acres of Fresno County lands in Class 1 and 2, eventually subject to irrigation.

Apricot Orchard Abandoned for Lack of Water

Applying our unit of water requirement developed in our study of the known territory to Classification No. 1 and 2, we arrive at a water demand of 3,075,069 acre feet per year, less the average annual water supply of 1,068,900 acre feet, would leave an annual deficiency in supply of 2,006,169 acre feet per year. Though we believe this method of arriving at the deficiency for ultimate possible development to be reasonably correct we do not wish to infer that this demand will ever actually occur, and we do not wish to intimate provision should be made for it as we realize much of this land could not be depended upon to meet charges for irrigation and much of it will not be subject to economic development within a reasonable time. However, we do believe that the State Plan should provide for some additional water over the amount of 794,800 acre feet per year that would be immediately usable upon availability.

Figures submitted by the San Joaquin Light & Power Corporation indicate there are in excess of 7,800 electric pumping plants in Fresno County, with a connected load of 70,000 H. P.; the actual average connected load being slightly less than 12 H. P. per plant. From the total KWH consumption these plants apparently operate in excess of 1,200 hours per season.

It is estimated that the average water delivery per plant is greater than 450 gallons per minute. From these elements conservatively taken at minimums we arrive at a figure of 780,000 acre feet per year pumped electrically.

In the Fresno Irrigation District alone there are 22% more gas engine pumping plants than electric and in all of Fresno County there are probably as many, though the water delivery from the gas plants is probably less than that of the electric plants, it appears evident to us that the total pumped water in the County exceeds 1,000,000 acre feet per year. This in a measure explains to us the drop

in standing water levels throughout the County during the past eight years ranging as follows:

Fresno Irrigation District ..... 5.3 feet
Consolidated Irrigation District ..... 8.5 feet
Alta Irrigation District ..... 12.5 feet
Mendota Area ..... 20. plus feet

The Power Company's investigations of electric pumping plant operations during the past eight years convinces them there has been an average drop in pumping levels of more than 20 feet."

The following statistics as to Fresno County are of interest:

Area, 5,950 square miles, 3,500,000 acres. (43 per cent of this area is in farms.)

Population, 1930 census, 145,558.

Population, 1920 census, 128,779.

Assessed valuation, $205,013,930.00.

Approximate actual valuation, $512,500,000.00.

Value of farm products sold in 1929, including cattle, hogs, dairy products, poultry and poultry products, $53,338,294.00.

1928 bank clearings, $202,470,272.00.

1928 postal receipts, $487,137.96.

County highway bonds, outstanding, $4,020,000.00.

School bonds outstanding, $6,985,375.00.

Irrigation district bonds outstanding, $3,375,000.00.

Irrigation district bonds, authorized, not sold, $2,270,000.00.

11.—KINGS COUNTY:

Unlike the other three Southern Valley Counties, Kings County has no stream of any size originating in its borders. It does not touch the Sierra Nevada Mountains, but extends to the Coast Range on the west. Its surface water supply is derived almost entirely from Kings River with a small supply from the Kaweah.

The area of the County is 889,500 acres, and of this 491,000 acres are in farms. Investigations disclose that 150,000 acres are not farmed on account of lack of water. The actual irrigated acreage is estimated at 300,000 acres with an average annual surface supply of 320,000 acre feet. The estimated requirement for the present developed areas is 900,000 acre feet, the shortage being 580,000 acre feet. As in the other three counties, this shortage is being made up by over-draft on the underground supply, with the accompanying lowering of water levels and ever increasing costs for pumping.

The State Land Classification gives Kings County 392,000 acres of No. 1 land and 217,000 acres of No. 2 land.

The following are the more important statistics for Kings County:

Population, 25,000.

Assessed valuation, $29,643,900.00.

1925 Farm Census valuation, $55,208,415.00.

No. of farms (1925 Census), 2,559.

Value agricultural products sold in 1929, including cattle, hogs, dairy products, poultry and poultry products, $16,604,675.00.

School attendance, 1929, 5,500.

Outstanding County Highway bonds, $321,000.00.

Outstanding Irrigation District bonds, $760,000.00.

In closing as to details of Southern San Joaquin Counties, we desire to call attention to the fact that these Southern Counties as we have classified them herein, coincide with the area studied by Mr. Harding in his Bulletin No. 11, entitled "Ground Water Resources of the Southern San Joaquin Valley. He there points out that there is in that area a more complete use of local water supplies than is found in any other similarly large part of the San Joaquin or Sacramento Valleys. He states the fact that the only local water supplies unused in the Southern San Joaquin Valley are such excess stream flow as exists in years of more than normal precipitation. There has been no such excess since 1923.

The Southern San Joaquin Valley has gone to the limit of its local water supply. That supply is deficient in the amounts herein set forth to maintain present development. Unless the situation can be relieved by importation of water, a vast amount of developed wealth, the fruit of immeasurable effort and sacrifice, must be lost, with all the attending train of human suffering and privation. Such a situation calls we submit for the generous assistance of the state and of the nation. It is no exaggeration to say that it is as great a threatened disaster, as the danger to the Imperial Valley from the floods of the Colorado River, and unlike that peril, it is a disaster certain to occur unless relief is obtained.

NORTHERN COUNTIES AS A WHOLE:

The four Northern Counties of the San Joaquin Valley, San Joaquin, Stanislaus, Merced and Madera, make up another agricultural empire, vastly contributing to the wealth and well-being of the state and the nation. Unlike their sisters to the south, they have either a developed or a potential local water supply adequate for their present and probably for their future needs. Their position in this matter is therefore essentially different from that of the Southern Counties. They do not seek water for themselves, but realize fully the urgent need for relief for the Southern Counties. Also it is apparent that the Northern Counties, extending as they do from the Sacramento Delta to the north line of the Southern San Joaquin Counties, will be both directly and indirectly affected by the construction and operation of works within their borders for the relief of the Southern Area, the major considerations in this regard being those involved in any exchange of waters now serving them, and the preservation of adequate drainage facilities within their borders. Also the irrigation districts in the Northern Counties are now under heavy bonded indebtedness incurred to develop their own supply of water. They feel that this local burden which they have assumed for their own water supply should relieve them from bearing any additional burden to aid other areas to obtain water. A summary of the major points with which the Northern Counties are concerned is as follows:

1. That if exchange of waters now serving them be affected, that their rights to a supply equal in quality and quantity to that which they now have, be fully assured and maintained at all times.

2. That if the channel of the San Joaquin River be used as a channel for conveying water to the Southern San Joaquin Valley by pumping up that channel, that provision be made to maintain drainage which some of the Northern Counties require, and for which they now use the San Joaquin River channel.

3. That some equitable adjustment be made to relieve districts which have incurred a bonded indebtedness for their own water supply, from bearing expense for providing water for other areas.

These points are treated more fully in the following detail as to each of the Northern Counties.

13.—SAN JOAQUIN COUNTY:

This county includes within its borders a part of the lower delta of the San Joaquin and Sacramento Rivers, where the encroachment of salt water presents a grave problem in the island farming area. We do not deem it proper or necessary to go at any length into this problem in this Brief. It is sufficient to say that the entire San Joaquin Valley recognizes the imperative need for a control of the salinity problem on Upper San Francisco Bay and in the Delta Region. We recognize it as a major element in the state-wide water problem, and we here reiterate our position that the time has arrived for California to adopt and go forward with the help of the Federal Government, to the construction of one comprehensive plan sufficient in scope for the ultimate conservation and economical use of all the waters of the state. Necessarily such a plan must embrace the permanent relief of those areas now suffering from encroachment of salt waters. We recognize further that in so far as the Upper Bay Region and the Delta Region reasonably require the waters from the Sacramento watershed which may be made available for their needs in relieving the saline condition, they have a right to waters necessary for the purpose, superior to the Southern San Joaquin Valley.

If the plan of using the channel of the San Joaquin River as a channel up which water is forced by pumps be adopted for the relief of the Southern San Joaquin Valley, there are areas in San Joaquin County as also in Stanislaus and Merced Counties, now dependent on that channel for drainage, which may be seriously affected by such permanent raising of the waters in the river channel. Attention is directed to this possible problem, as one which will have to be cared for in the event that plan of water transportation to the Southern San Joaquin Valley is adopted.

14.—STANISLAUS COUNTY:

This county is probably the most favored of all the San Joaquin Valley Counties in its water resources. These resources are in a very high state of conservation and well-regulated use. It is estimated that the irrigation supply for the County as now developed and with extensions now proposed, is ample for irrigable erea in the County, except possibly a tract of a few thousand acres in the extreme Southwestern part of the County.

Careful records are kept by the agencies, principally irrigation districts, which distribute the waters of the County, and from these, the following statistics for the year 1928 are of interest:

Total area under water systems, 411,663 acres.

Total area actually irrigated in 1928, 262,298 acres.

Capital cost of water systems, $25,015,789.00.

Bonds outstanding for water systems, $17,443,401.00.

Average cost for water in 1928 per acre irrigated, $5.96.

There is a very considerable drainage problem in parts of Stanislaus County, particularly in the western portion. The San Joaquin River is used as a drainage channel to an increasing extent, and if the waters of that channel are held to higher levels, and their flow reversed by pumping water to the Southern San Joaquin Vally, this facility of drainage for Stanislaus County may be seriously impaired. Attention is directed to this, as a problem which gives considerable concern to San Joaquin, Stanislaus and Merced Counties in connection with the present proposed plan for the relief of the Southern San Joaquin Counties.

The Engineers of the District having this drainage problem or familiar with it are unanimous however in declaring that it can be readily and permanently solved without excessive cost in the event the San Joaquin River Channel is used for pumping to the Southern Valley Counties.

15.—MERCED COUNTY:

This is another fortunate county with excellent water resources, most of them well-developed and used by the great Merced Irrigation District. There are two sources of supply, the Merced River furnishing water for the lands in the easterly part of the County, and the San Joaquin River supplying the western part. It is estimated that in all years of normal run-off, the Merced River will amply supply all irrigable lands in the eastern section of the County. As to the western part, it is estimated there are now approximately 40,000 acres of irrigable land which receive no water from the San Joaquin River. Water now used for flooding pasture areas, however, is available and might be purchased in sufficient quantity to supply these lands. The estimate of a sufficient available local water supply for all the irrigable lands in Merced County is based upon the Land Classification recently completed by State Engineer Hyatt.

A large area in western Merced County now receiving water from the San Joaquin River would be affected by the exchange of waters proposed in the plan of pumping water up the San Joaquin River. Naturally Merced County looks upon this proposed exchange with great interest, and it seems appropriate here to reiterate two principles in this regard for which the entire San Joaquin Valley stands and which we are sure must be and will be firmly adhered to in putting into effect and operating a State-wide plan of water co-ordination. These principles are:

(a) No water or water rights which have been dedicated to a public use or are in process of being dedicated to public use, shall be lessened or prejudiced by condemnation, either for irrigation or power purposes.

(b) Exchanges of water when necessary shall be effected only with full permanent protection to existing water rights, and water rights in process of acquisition, or other vested interests. In any exchange of water, upon actual delivery of any water from a local source for use elsewhere, it shall be replaced at all times immediately with an equal quantity and quality; and in effecting any such exchange nothing shall be done to the detriment of the users yielding up their local supply in exchange for lieu water.

Like Stanislaus County, Merced County is concerned as to its drainage problem if the San Joaquin River pumping plan is adopted. Those most conversant with the general

water situation in that County feel that if this plan is carried out, provision must be made to avoid increased seepage into large areas and to maintain drainage for areas which now drain into the San Joaquin River.

It must not be deemed that in reiterating this drainage problem, we are offering any criticism of or opposition to any proposed plan. This Brief is an effort to candidly and frankly present the situation of all the San Joaquin Valley Counties as affected by the State-wide Water Plan and to bring to attention all the factors which the different counties feel must be taken into account if the plan is to be put upon a sound and equitable basis. Merced County joins with all the other counties of the Valley in urging relief for those areas in the Southern San Joaquin Valley now developed, in order that that development be not destroyed through lack of water.

16.—MADERA COUNTY:

This County occupies the position of having a potential water supply in the San Joaquin River, and the Fresno and Chowchilla Rivers adequate to its needs, but requiring conservation by storage not yet in effect as well as some pumping development. The Madera Irrigation District is now engaged in carrying forward plans for this storage and pumping development on a large scale. Mr. Harry Barnes, Engineer of Madera Irrigation District, has made the following statement for Madera County:

"There are approximately 340,000 acres in the Madera Irrigation District, but the present plan for first development embraces the irrigation of 200,000 acres of this area. For this there will be required an average of 350,000 acre feet of water per year from the San Joaquin River and it will be necessary to develop approximately 100,000 acre feet of storage to carry this into effect. There is also contemplated a development of 100,000 acre feet per annum from the underground supply. On the Chowchilla and Fresno Rivers, each one of which has an approximate yearly run-off of 60,000 acre feet, it is possible to develop storage of from 60,000 to 70,000 acre feet and these two rivers will then irrigate approximately 50,000 acres of land. The ultimate development of the lands in Madera County would require water for 400,000 acres. This full development would require 650,000 acre feet of water annually from the San Joaquin River and an additional 100,000 acre feet from pumps."

"Within the Madera area there is at present a small public utiltiy—The Madera Canal & Irrigation Company—which draws its supply from the Fresno river. The flow ceases in the late spring or early summer. The total diversion of this system does not exceed at any time 200 second feet. The total annual diversion is about 25,000 acre feet. The system is inadequate, the land so served receiving only about 1.25 acre feet per year. Land covered by this system comprising about 10,000 acres is also served by privately owned pumps which are necessary to supplement the deficiency in gravity supply. In addition to this area there are about 65,000 acres now under cultivation which depend entirely upon privately owned pumps for irrigation."

"As in the four counties in the southern half of the valley, the underground water table of Madera County is being rapidly depleted. The records of over 300 wells for the past ten years indicate that the underground water table is receding at the rate of 2 feet per annum."

"Within the last three or four years pumping plants are being installed in ever increasing numbers, the minimum average lifts in the northern portion of the county will average about 60 feet; in the central portion of the county about 55 feet; and in the southern portion of the county about 70 feet."

"The quantity of water now being pumped out of the ground is estimated at approximately 200,000 acre feet per annum, while the natural underground recharge from the Fresno River, Chowchilla River, San Joaquin River, Cottonwood Creek and other inconsequential streams including all sources of supply, amounts to only about 45,000 acre feet per annum. The underground supply available for pumping is thus being depleted at the rate of 155,000 acre feet per annum."

Having now presented what seem to be the principal facts as to each of the eight Valley Counties we pass to some final considerations, which, though of the greatest importance in this tremendous problem, can be touched on here, very briefly.

17.—FINANCING INITIAL COST AND COST OF OPERATION:

It will at once be recognized that until the most feasible plan from an engineering standpoint for the importation of waters into the Southern San Joaquin Valley is finally determined, its initial cost accurately estimated, and its cost of operation also accurately calculated, little of value in the way of definite conclusions can be obtained by discussing how those costs can be paid. All that can be done here in that regard is to make our position clear in a general way, and we therefore state that position as follows:

(a) Those who will receive and benefit from any water imported into the Southern San Joaquin Valley are willing to pay for that water whatever amount they can reasonably afford. One of the most perplexing elements in the whole problem is the determination of what that amount shall be. It would, of course, vary so far as ability to pay it is concerned with the rise and fall in the market values of agricultural products. For the same reason a variation in ability to pay or in value of water will be found among different crops. At present the value of water for citrus trees is far in excess of its value for alfalfa, vineyards, cotton or other crops. Such study as this Committee has been able to give to this element of the general problem is not sufficient for the expression of more than a general opinion, and it may be said that even this opinion is not shared by some members of the Committee, chiefly because of lack of sufficient information.

Experience in many irrigation and reclamation projects has, however, demonstrated the wisdom of erring on the side of conservatism in estimating the amount of annual charge which farming areas will be able to pay for a supply of irrigation water. With these elements in mind, the opinion is here expressed that under present economic conditions the farmers of the Southern San Joaquin Valley as a general average are able to pay $4.00 per acre foot for water delivered at the edge of their respective parcels of lands ready for their use. We await with interest the results of the study now being made of this particular phase of the problem by the College of Agriculture of the University of California.

(b) We have before said, and now repeat that in our opinion the magnitude of the disaster which threatens the Southern San Joaquin Valley is such as to concern not only the State of California, but the United States. The effect of the destruction of a great part of the splendid agricultural development in that area would be felt throughout both the state and the nation. Therefore, we earnestly feel that financial aid in a very substantial amount for the initial cost should come from the government of the United States, with the State of California contributing the balance of initial cost necessary through the issuance of its bonds. Whether or not the amount which those areas which receive the water can afford to pay for it will be sufficient to repay the initial cost with interest, over a long term of years is at this time impossible to state, first because there is now no estimate of initial cost, and second, because the amount which water users can pay, or the cost of operating the system has not been determined. It seems certain, however, that with a low rate of interest, the income from water charges would, over a long term of years, go far to discharge the debt. If there be a deficiency, in this regard, we submit, for the reasons heretofore stated, it is one which the state and the nation could well afford to pay, for surely the indirect benefits which will flow to other areas from the preservation of the Southern San Joaquin Valley in economic vigor, will justify that assistance to it from the state and the nation.

(c) In our opinion the magnitude of the works and expense involved will not warrant it being financed by the organization of a district involving only the areas benefited. Those areas are willing to pay to the limit of their ability for the special benefits they will receive, but as a matter of financing initial cost this project is so vast that in our opinion the aid of the United States government in part, and the loaning of the credit of the State of California in part, are necessary for its accomplishments. There are many examples where the United States Government has come to the aid of imperiled areas under similar circumstances and the San Joaquin Valley here presents its case for that aid, in full confidence that it will be given; and always affirming the willingness of those areas benefited to repay up to their ability to do so.

(d) We feel that those Districts such as Modesto, Turlock, Merced and others throughout the state which have bonded themselves heavily to provide their own water supply, and are not asking for aid by way of additional water supply in this matter should not be, directly or indirectly burdened with taxation to pay state bonds in the event the credit of California is pledged for this project. The basis of this feeling is that since those districts are required to pay and have bound themselves to pay for their own water supply, they should not be required to help pay for a supply for other areas. The difficulty of making an equitable adjustment in this regard is recognized. Some suggestion has been made that in the event of a state bond issue for this project, if the state as a whole be taxed to repay all or a part of such bonds, then that an adjustment should be made by the state assuming or taking up an equitable part of the outstanding bonds of those districts which have provided their own water supply by bonding themselves. Whether or not such a plan of tax refund by the state to such districts is possible from a practical standpoint involves elements too complex for presentation here. We can only mention this as one element of the financing problem which merits serious consideration.

18.—ADMINISTRATION AND OPERATION OF SYSTEM:

The ultimate plan for the administration and operation of any system devised for the importation of waters into the Southern San Joaquin Valley, rests in the decision of the Federal-State Commission, the Joint Legislative Committee and the Department of Public Works, finally approved by the Legislature of California, and the Congress of the United States if Federal aid be given. Without intruding upon the authority to make that decision, we present the following suggestions as the considered opinion of the San Joaquin Valley Water Committee:

(a) The State of California through properly authorized officials, and with such cooperation with Federal authorities as is deemed proper in the event of Federal aid, should control and operate the main canal and general system for the transportation of the water.

(b) The water should be allotted and sold from the main canal to local districts now or hereafter properly organized in the areas affected, and such districts should at their own expense provide all laterals and distributing facilities necessary to bring the water from the main canal to the individual parcels of land, and should control such distribution as well as pay its expense.

(c) The control by the State of the allotment of water should be exercised in such manner as to furnish water first for developed lands and regulate so far as possible the development of any new lands so as to accord with economic justification for such new development.

(d) In the four Southern Counties, organizations and physical facilities for taking and distributing all the water needed for present development are now available in Fresno County, and also to a large extent in Tulare County. As to the latter county we refer here to Alta Irrigation District, Foothill Irrigation District, Tulare Irrigation District, Lindsay-Strathmore Irrigation District, Terra Bella Irrigation District and Alpangh Irrigation District. The same is true of Kings County which now has several such districts. Kern County has no irrigation district, but there is an extensive canal system now constructed which would avail for distribution over much of its area.

19.—CONCLUSION:

It is our earnest hope that herein we have made the situation of the San Joaquin Valley and its general attitude toward the Water Problem of California very clear. We have not presumed, and do not presume to advocate any particular method or plan for the solution of that problem in whole or in part. The decisions in these matters rest with the Federal-State Commission, and the Joint Legislative Committee, and we have the utmost confidence that those decisions will be wisely and justly made. Our thanks are due and are tendered for the courtesy and consideration which has been at all times extended to the representatives of the San Joaquin Valley by the members of the Commission and the Committee and by State Engineer Hyatt and his assistants. We feel that the earnestness and ability with which the great problem of conserving and making useful the full water resources of California is being now studied in every detail, merits and will receive the

highest public commendation and will result in immeasurable benefit to the nation and to the state.

The San Joaquin Valley rests its case upon its need, and upon what it contributes and will contribute to the economic and social welfare of the nation and the state if help be now given it. It asks for no water if thereby any other area which has and needs, or ever will need that water, would thereby be deprived thereof. It recognizes that its problem is by no means the only water problem in California and it stands squarely for the adoption now of one comprehensive plan to co-ordinate and conserve the water resources of California. It submits that no plan worthy of the name can be devised which will not include sufficient provision to assure life and continued prosperity to the great territory whose present desperate plight we have endeavored to portray herein.

Respectfully submitted,

SAN JOAQUIN VALLEY WATER COMMITTEE

By C. H. WARLOW, Chairman.

JAMES M. BURKE, Vice-Chairman.

ATTEST:

M. P. LOHSE, Secretary.

APPENDIX

TULARE COUNTY WATER SITUATION IN DETAIL

As in all irrigated areas, the first utilization of water for irrigation in Tulare County was from the surface flow of streams. The streams which supplied this use were, a diversion of part of Kings River in the north end of the county, the Kaweah River and the Tule River, and a minor supply from Deer Creek. Agricultural development dependent on the surface flow of these streams, had practically reached its limit by the year 1900. Before that year all of the waters in the Kaweah and Tule Rivers had been appropriated, and ditches built having an aggregate capacity sufficient to carry the flood stages of the rivers. The Kaweah River and the Tule River both have wide fluctuations of flow from season to season and from period to period. They have been and are at all times unregulated streams, and necessarily the amount of permanent agricultural development which can be maintained from their surface flow is limited by the lower stages of that flow. The maximum amount of land that was ever irrigated from the surface flow of the Kaweah River, in one season was 101,728 acres, this including 19,750 acres located in Kings County. The maximum amount ever irrigated from the surface flow of Tule River, in one season, was about 25,000 acres. Both of these figures include considerable flooding of pasture lands during flood stages, so that the amount of land which could be irrigated on a permanent agricultural basis from the surface flow of these two streams would not exceed 60 per cent of the acreage stated, and this development had been reached by the year 1900. The diversion from Kings River on the north into Tulare County could care for a permanent development of 50,000 acres and approximately 1000 acres could depend on Deer Creek. Thus the entire area in Tulare County that can now or ever could depend for permanent agricultural development on the surface flow of streams was and is approximately 111,000 acres.

The population of the County in 1900 was 18,375.

The population of the County is now 75,740.

The assessed valuation of the County in that year was $13,550,274.

The assessed valuation of the County in 1929 was $97,250,548.00.

Had it not been for the development of pumping for irrigation, Tulare County could never have grown in population or wealth appreciably beyond that of 1900. The development of the County from 1900 on is based on pump irrigation. Its history is the history of the electric power companies operating in the territory, as it was the development of electric power that made possible the great use of irrigation pumps.

The first hydro-electric generation plant was constructed on the Kaweah River in 1899. It was largely financed on the basis of the possibility of using electricity for pumping water, which possibility had been indicated by a few more or less successful efforts in what is now the Lindsay orange district at pumping water with old style steam threshing engines. The water in that district then stood within easy reach of centrifugal pumps placed in very shallow pits. Development of pumping with electricity at first proceeded very slowly. It was confined almost exclusively to the irrigation of oranges and high class crops in the foot-

hill districts around Exeter, Lindsay and Porterville. In 1905 a survey showed a total of 175 irrigation pumping plants in the County, 125 being electrically driven and the remainder with gasoline engines. In 1907 it was estimated that a total of 18,000 acres in the County were being irrigated by pumping, 14,500 acres of these being by means of electric power. Even at this time most of the pumping was for citrus orchards, and for vineyards, only a very small percentage being for alfalfa or other field crops. By 1912 the pump-irrigated area had increased to 40,000 acres and by 1914 to 49,000 acres. Of this, about 44 per cent was citrus orchards. The development since 1914 has been extremely rapid as shown by the growth of the electric pumping load set forth in the following table taken from the records of Southern California Edison Company, these figures excluding booster pumps, and all motors under 3 horse power:

Year	Connected H. P. Load	Year	Connected H. P. Load
1914	10,000	1922	41,500
1915	10,600	1923	44,200
1916	14,000	1924	47,046
1917	17,300	1925	57,316
1918	24,400	1926	66,561
1919	26,800	1927	69,218
1920	32,600	1928	74,526
1921	36,300	1929	84,776

On a previous page of this Brief we presented a table showing the immense development of electrical pumping in the four Southern Counties during the past 6 years. An analysis of what the figures in that table indicate cannot be made for each of the counties because sufficient data is not available, but it can be made for Tulare County because of exhaustive investigation made in that county. That analysis reveals that the increase of pumping load from year to year, and the startling total of kilowatt hours used in each of the counties during the last two years, are not the evidence of or the result of community prosperity or development. They have a different and more sinister meaning, because they best indicate the ever intensifying struggle to maintain developed farms against deficient water supply, falling water levels, and mounting costs for irrigation absorbing the profits of the crops raised.

(b) Effect of Pumping in Tulare County.

This study of the effect of pumping in Tulare County has been pursued along two general lines; (1) The physical Effects, and (2) The Economic Results and Economic Problem Involved. This study has been made during the past 2½ years by Mr. C. H. Holley, now Engineer for the Tulare County Water Commission, and has been exhaustive in every element. It has included a part of Northern Kern County as well as Tulare County.

As to the physical effect of pumping there has been studied the relation of pumping draft in the various areas to the lowering of ground waters in order to ascertain the amount

of replenishment in these areas; a study of the total consumptive use of water considering both the run-off from the streams and the loss from underground in order to determine the deficiency of supply to maintain the present development.

Within the limits of this Brief it is not possible to discuss fully all of these elements. The best that can be done is to present some of the most striking facts, and data to show present conditions and the inevitable result of the present trend.

This Brief is accompanied by four maps, which best show the effect of pumping in Tulare County.

Map No. 1 shows the depth to ground water throughout Tulare County and Northern Kern County at the end of the pumping season of 1929.

Map No. 2 shows the amount of lowering of underground water levels that has occurred from November 1st, 1924 to November 1st, 1929.

Maps 3 and 4 indicate the spread of the area within which the irrigation of alfalfa by pumping either has had to be abandoned on account of increasing costs, or is rapidly approaching that condition.

Map No. 1 showing depth to ground water at the end of the year 1929, is the result of close observation for a number of years of about 1300 wells scattered throughout the area, the ground water changes in these wells having been recorded several times each year. It will be noted that the depth of water in these areas directly supplied by the Kaweah River and Tule River are moderate, 15 or less, close to the rivers but that the depth rapidly increases as the distance from the source of supply increases.

As the depth to ground water is one of the controlling factors in the cost of pumping, and as this cost finally becomes the limiting factor in the raising of crops adapted to various areas, it is important to know the amount and kind of crops raised in each area. An attempt has therefore been made to show these facts on this map for each Township, the crop survey having been made in the fall of 1929.

Later in this Appendix the limitations of cost of water for various crops will be discussed, and this Map No. 1 again referred to, to point out the areas and kinds of crops where the pumping cost is now approaching the maximum that can be borne.

Map No. 2 shows, by means of contour lines, the amount of lowering of water levels that has occurred from 1924 to 1929.

On this map is also marked in each Township, the amount of kilowatt hours used by the electric pumping plants. As the record of the amount of kilowatt hour consumption is available for every pumping plant for a number of years, it is possible to calculate with a fair degree of accuracy the pumping draft in each area for each year.

While there has been a general lowering of the ground water throughout the entire area of Tulare County, amounting to very serious proportions, there are certain localities where a concentration of development, and corresponding pumping has caused a lowering greatly in excess of the average. It is in these areas that the situation is most critical, and where the pumping costs are rapidly approaching the economic limit. These areas and special conditions will later be considered.

(c) Tulare County. Water Resources, Requirement, and Deficiency of Supply.

As already noted, the water supply of Tulare County and Northern Kern County is derived from the following sources:

1. Kings River, Diversion by Alta Irrigation District for lands partly in Tulare County and partly in Fresno County with a small area in Kings County.
2. Kaweah River. Supplies surface water also to an area of about 25,000 acres in Kings County.
3. Tule River.
4. Deer Creek.
5. White River, Rag Gulch and Dyer Creek in Southern Tulare and Northern Kern, with a few minor creeks which flow only in seasons of heavy rainfall. None of the streams or creeks in this item is directly utilized because their supply in the aggregate is small and independable.

We now consider the areas irrigated by the four main sources of supply.

1. The Alta Irrigation District receives a varying supply from Kings River, depending on the flow in that stream, and ranging from the extreme low diversion of about 15,000 acre feet in 1924, to about 256,000 acre feet in 1927. The approximate annual diversion is 160,000 acre feet. In the last 15 years there has been a very rapid development in this District chiefly in the planting of vineyards. Due to this, in recent years, pumping has had to be resorted to in increasing measure to supplement the surface supply. The extent of this pumping and its growth since 1924 is revealed by the pumping power records of the "Dinuba District" of San Joaquin Light & Power Company which District roughly corresponds with the limits of Alta Irrigation District. These records are as follows:

Year	No. of Consumers	H. P.	K. W. Hrs. Used
1924	1075	7,710	14,444,501
1925	1266	9,261	12,792,572
1926	1671	13,024	16,846,544
1927	1900	14,058	12,484,098
1928	2038	15,206	18,977,685
1929	2232	17,294	22,120,209

In addition to the electric plants there are several hundred gasoline engines utilized for pumping in this District.

The effect of this pumping has been to produce a steady lowering of the ground water which is particularly marked in the eastern part of the District. This condition will soon be aggravated by the fact that alfalfa and cotton requiring a larger quantity of water are being now extensively substituted for the vineyards.

The crop survey of 1929 showed 7150 acres in alfalfa against 4690 in 1925, and 1800 acres in cotton against 200 in 1925. This change would require about 10,000 more acre feet than the original crops.

The deficiency of supply for this District as a whole to maintain present development is not less than 85,000 acre feet, annual average, and the District is about 60 per cent developed.

2. The Kaweah River is the principal river of Tulare County, and is practically the sole source of supply for an immense area extending fan-shaped from the apex where the River emerges from the foothills, to the trough of the valley where it merges with the Kings River Delta on the west and north, and the Tule River Delta on the South. There are over 300,000 acres of rich alluvial soils in this area, capable of the highest production of various crops.

The flow of the Kaweah River is subject to wide annual and seasonal variations, the extremes of recorded flows being 1,090,000 acre feet in 1906, and only 102,000 acre feet in 1924. Neither of these extremes is of much value in determining an average flow. The average annual flow for the 10 year period following from October 1st, 1909, was 397,000 acre feet; while the average annual flow for the 9 year period from October 1st, 1920, was 310,125 acre feet.

3. The Tule River's total discharge is not so accurately known as that of the Kaweah, but on the basis of the measurements available, its annual average flow for the 9 year period preceding October 1st, 1929, was 81,000 acre feet. All of the surface flow of Tule River is utilized within the upper portion of its delta, and none has reached the lower delta on the surface in recent years.

4. Deer Creek has a very limited flow which is all absorbed by seepage into the cone of depression caused by pumping along the Creek channel. A fair estimate of the average annual flow for the past 9 years is 11,000 acre feet.

Thus the total annual average surface flow into Tulare County south of Alta District, and not considering casual run-off from the foothills and minor streams is as follows:

Kaweah River	310,125 acre feet
Tule River	81,000 acre feet
Deer Creek	11,000 acre feet
Total	402,125 acre feet

Out of this, the Lakeside Ditch area in Kings County has received an average of about 36,000 acre feet per year, leaving about 366,000 acre feet for Tulare County.

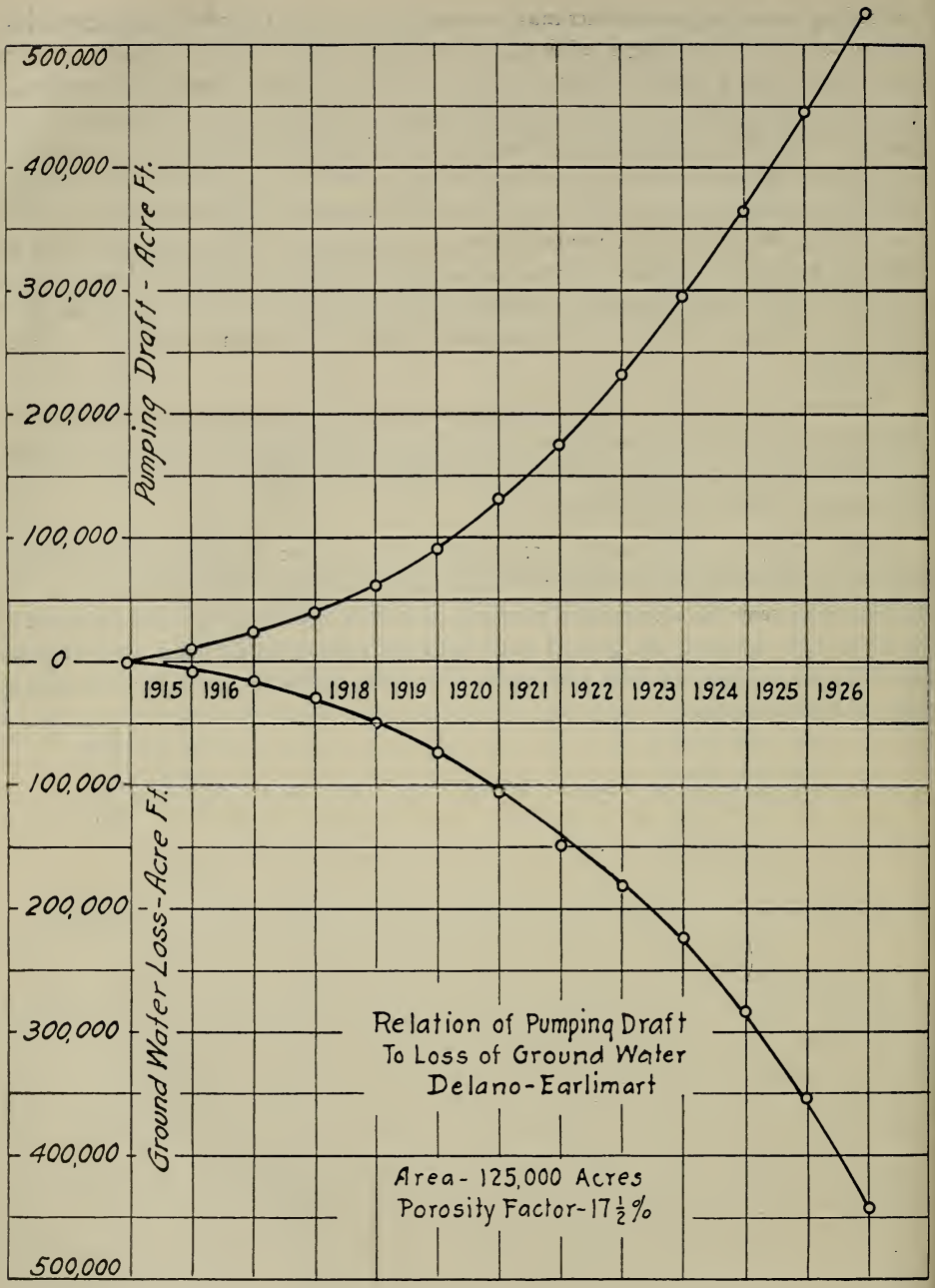
Exclusive of the Alta District, and certain other small areas in the northern part of Tulare County, but including the area about Delano in Kern County, the total acreage of irrigated land dependent on this surface water supply and on the accumulated underground supply is 288,789 acres. In addition to irrigation there is the demand for human and animal consumption, municipal uses, and necessarily a loss from evaporation and support of native vegetation. Assuming 20 per cent of the surface flow as thus used for purposes other than irrigation or unavoidably lost, we find that the surface water supply in this great area for the lands now irrigated is about one acre foot per acre per year. Here is the explanation of the terrific over-draft on the underground supply evidenced by its steady lowering from year to year.

The total consumptive use of water in any area for any given period is the sum of the surface flow into the area plus the loss of water from underground supply. This total use includes all uses as well as all losses. A part of the stream flow replenishes the underground waters, also part of the pumped water gets back to the underground supply and is re-

pumped, so the underground water may be considered as a great reservoir, raising and lowering in response to changing conditions, and recording by its elevation from one period to another, the relation between demand and supply. The amount of lowering that occurs in the ground water is therefore an accurate measure of the deficiency of supply, and in estimating the deficiency that exists in Tulare County and Northern Kern, the amount of this lowering converted into units of quantity is the basis. Neither the surface flow on one hand nor the pumped water on the other can be taken as the measure of the deficiency. It is true there has been in several years, a reduced annual stream fllow in Tulare County during the past nine years as compared with previous periods, and this is reflected in lower ground water levels than might otherwise have been, but this by no means accounts for the great lowering which has occurred. The predominant cause is the steady excess of demand over supply.

The amount of this lowering in any given area is of course dependent not only on the draft but on the rate of replenishment. It varies according to many factors and according to seasonal variations in rainfall, and is of course different for different areas. We can only give therefore a few striking illustrations.

One of these is shown on the accompanying chart of the relation between pumping draft and ground water loss in the Delano-Earlimart area. The curve on the upper part of this chart represents the accumulated pumping draft from 1916 to 1926, while the curve on the lower half represents the ground water lowering reduced to the same units of quantity. The near equality of these two curves is startling in that it shows there is substantially no replenishment.



ANNUAL AND ACCUMULATING DEFICIENCY

A general study of actual irrigation demand against actual supply in Tulare County for the period 1924-1928 shows an average annual shortage, conservatively estimated, of

520,300 acre feet, determined for the different areas as follows:

TABLE—SUMMARY OF IRRIGATION IN TULARE COUNTY AND DEFICIENCY OF SUPPLY BASED ON AVERAGES FOR PERIOD 1924-1928

Name of Area	Gross Acres	Acres Irrigated	Deficiency of Supply in Ac. Ft.
(1) Alta Irrigation District	95,000	55,000	85,000
(2) Foothill Irrigation District	25,000	9,000	20,000
(3) South of Alta Dist. to Kaweah River	75,000	20,850	16,500
(4) Kaweah River Delta	209,000	84,000	105,000
(5) Tule River Delta	109,000	32,600	55,000
(6) Between Kaweah and Tule River Deltas	117,000	50,300	88,000
(7) South of Tule River	328,000	55,850	150,800
Totals	985,000	307,600	520,300

In 1929, it is estimated the actual shortage was approximately 10 per cent in excess of this, or a total of 575,000 acre feet. This is based solely on the requirements of present irrigated lands, and is exclusive of domestic uses, municipal supply, and unavoidable losses.

Another method of determining the annual deficiency is to determine the amount of ground water leveling in a given area and apply to it well recognized factors of porosity. This method has been applied for five years commencing in 1925 to the valley area of Tulare County south of Alta District and that portion of Kern County as far south as McFarland. The annual lowering in each township was determined each year commencing in 1925 and well recognized factors of porosity applied to it.

The results of this calculation are as follows:

Year	Loss in acre feet	Accumulated Deficiency Acre feet
1925	302,000	
1926	479,000	781,000
1927	295,000	1,076,000
1928	544,450	1,620,450
1929		

The average annual deficiency over this five-year period is 408,850 acre feet. To this should be added an annual average shortage of 100,000 acre feet in supply for those portions of Alta Irrigation District and Foothill Irrigation District in Tulare County, making a total annual average deficiency revealed by actual lowering of underground waters in the area so studied, of 508,850 acre feet. The accumulated figures of deficiency for those five years show thta in those five years it has been necessary in orde rto support present development to draw upon the underground supply in an amount exceeding the replenishment thereof by 2,044,400 acre feet. Comment seems unnecessary. The result of that overdraft and the best indication of what it will mean in continuing and increasing amount as the years go on is shown by a few actual photographs herein presented of orchards in Tulare County abandoned because of lack of water after full development had been attained.

ADVANCING COSTS OF IRRIGATION AND ECONOMIC LIMITS IMPOSED THEREBY

The constantly dropping level of underground waters is reflected in constantly increasing costs for power, with increasing investments in new equipment necessary to draw the water from the greater depths. In Tulare County a careful stud yof this trend has been made for the past six years. This study shows that in several areas the costs for water are now approaching the limit that many crops can bear.

For the purposes of this study the records of the Southern California Edison Company and of San Joaquin Light & Power Corporation were made available. They are the only companies furnishing electricity in Tulare County. These records being very complete, show:

(a) Record of operation of all pumping plants for period of several years.
(b) Record of changes made in pumping equipment.
(c) Increased power required at different plants.
(d) New plants or new equipment installed.
(e) Total kilowatt hours consumed by each plant each year.

Applying the facts from these records to crop surveys made, we have a very complete picture of what has happened and is happening.

The most intensive study along this line has been made in what are known as Tulare District of Southern California Edison Co., and Delano District of that company.

The Tulare District of Southern California Edison Co. extends from a line midway between Visalia and Tulare on the north, to Pixley on the south, and from the west line of Tulare County to a line midway between Lindsay and Tulare on the east. There are wide differences in underground water conditions between various parts of this District. The eastern and northeastern portion thereof is far better supplied with replenishing water than the western portion.

The steady increase in use of power for pumping in this District without corresponding increase in acreage irrigated is shown by the following table:

Year	Acres Irrigated	H. P. Used for Pumping
1924	64,808	12,034
1925	65,617	14,425
1926	66,903	17,013
1927	67,500	17,364
1928	70,900	18,943
1929	74,638	22,590

It will be seen that while acreage irrigated increased 15 per cent in 6 years, power used for pumping increased 87½ per cent.

The Delano District embraces the south part of Tulare County south of the Tulare District, and also a portion of the northern part of Kern County extending south to McFarland.

In the Delano District the increasing use of power is as follows:

Year	Acres Irrigated	H. P. Used
1924	33,559	10,402
1925	38,430	13,597
1926	39,240	15,245
1927	39,320	15,996
1928	41,837	17,182
1929	43,553	18,677

As in the case of Tulare, the ratio of horse power to acreage is rapidly increasing. Here we find that while the acreage has increased 30 per cent the horse power has increased 79½ per cent.

Coming now to the actual amounts of energy used for pumping in the different years we have the following table.

This table shows the average kilowatt hours consumption per acre for the different years, together with the average rate per kilowatt hour that prevailed in those years from which is calculated the average cost of electric power per acre irrigated.

TABLE SHOWING PROGRESS OF IRRIGATION DEVELOPMENT AND INCREASING COST PER ACRE FOR PUMPING

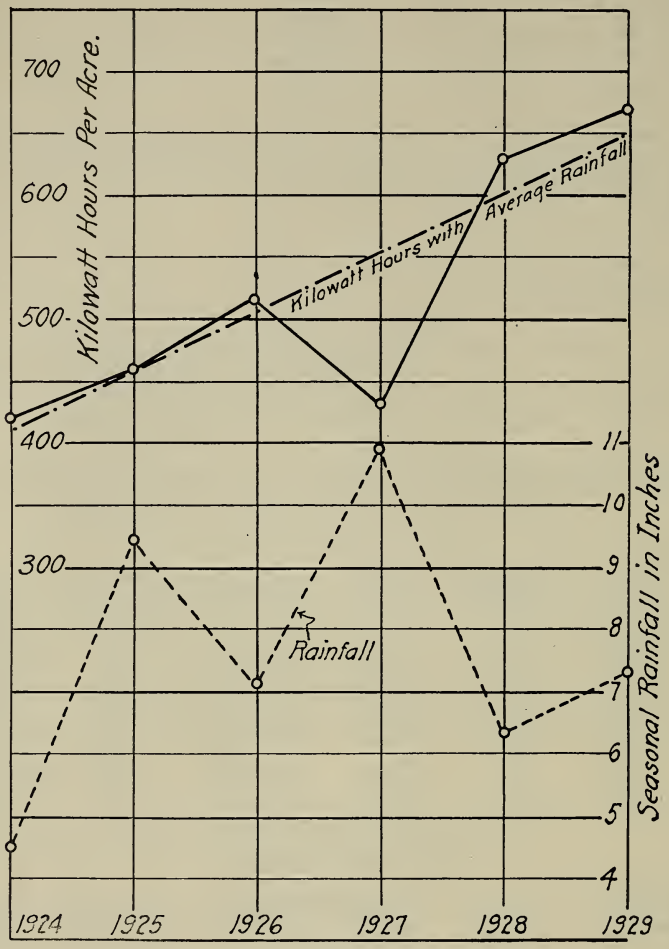
TULARE DISTRICT

Year	Acres Irrigated	Number Plants	Horse Power	Kilowatts Hrs. Used	Av. Kw. Hr. Per Acre	Av. Rate	Cost Per Acre
1924	64,808	1,124	12,034	27,252,563	420	0,0133	$5.58
1925	65,617	1,228	14,435	30,106,780	458	0.0132	6.04
1926	66,903	1,340	17,013	34,475,817	515	0.0127	6.54
1927	67,500	1,340	17,364	28,927,652	430	0.0141	6.06
1928	70,900	1,385	18,943	44,544,726	629	0.0127	7.99
1929	74,638	1,485	22,590	49,720,646	667	0.0125	8.33

DELANO DISTRICT

Year	Acres Irrigated	Number Plants	Horse Power	Kilowatts Hrs. Used	Av. Kw. Hr. Per Acre	Av. Rate	Cost Per Acre
1924	33,606	627	10,402	25,892,189	771	0.0123	$9.48
1925	38,430	713	13,597	30,734,898	797	0.0125	9.96
1926	39,240	705	15,245	35,993,215	917	0.0123	11.28
1927	39,320	698	15,996	32,885,887	835	0.0130	10.85
1928	41,837	712	17,182	43,786,600	1049	0.0120	12.59
1929	43,553	730	18,677	47,385,296	1089	0.0119	12.95

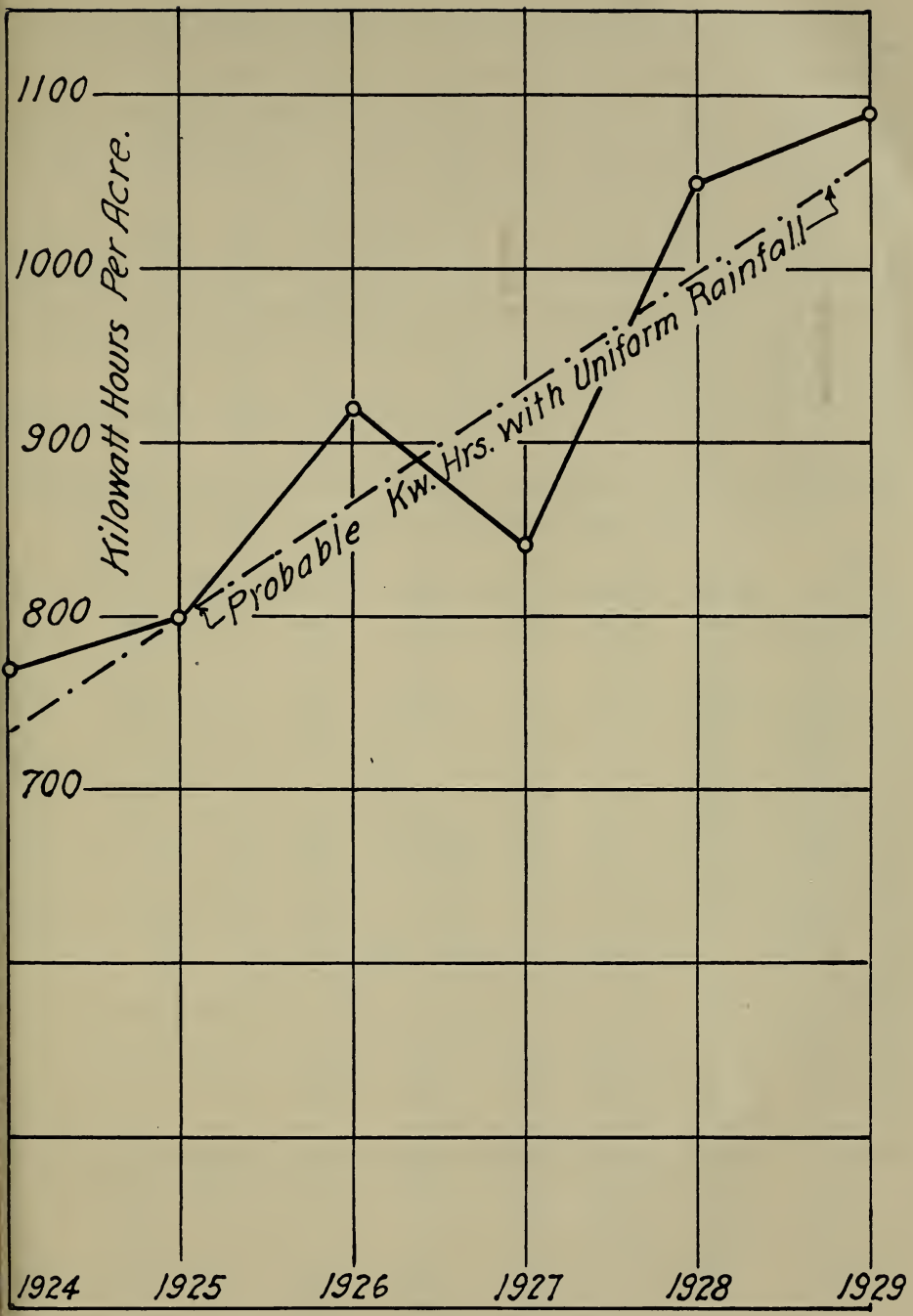
These average quantities are so important as showing the trend of costs in these districts that charts showing them have been prepared and are here attached.



INCREASING POWER CONSUMPTION, TULARE DISTRICT

The great drop in average use in 1927 due to extra rainfall is here well shown. The saving in energy that was made amounted to about 100 kw. hrs. per acre or an actual saving to the farms of $1.20 per acre for that year.

The increasing cost per acre for pumping due to the increasing amount of power used, has already amounted in the aggregate, for these two districts alone, to a very large sum of money.



INCREASING POWER CONSUMPTION, DELANO DISTRICT

To estimate what this amount is, consider that the same average rate per acre that prevailed in 1924 had continued throughout the period and we find that the additional amount that the farmers of Tulare District paid from 1925 to 1929 is $502,934.00.

In the same manner, it is found that the farms of the Delano District had to use additional energy for pumping to the extent of $419,364.00 or a total additional expenditure for energy alone in these two districts of $922,298.00 for this five year period. For 1929 this additional energy required, cost over $350,000 in these two districts.

It will be noted that there has been a total increase in acreage irrigated in these two districts since 1924 amounting to about 20,000 acres. This on the face of it might be considered as an evidence of advancing prosperity. But a comparison of the kind of crops irrigated in 1924 with those of 1929 will give a better idea as to the relative permanence and community benefits of the two conditions.

Such a comparison is given in the two tabulations which follow which show the total acreage in each class of crop for the two districts for 1924 and 1929.

CLASSIFICATION OF CROPS IRRIGATED BY PUMPING IN TULARE DISTRICT OF SOUTHERN CALIFORNIA EDISON CO.—1924

Tw.-Rg.	Alfalfa	Corn	Cotton	Vines	Misc. Or.	Truck	Ir. Grain	Total
S½ 19-23	2,349	335	30	392	218	—	325	3,649
S½ 19-24	2,826	710	550	1,242	624	15	786	6,753
S½ 19-25	1,691	308	—	1,150	2,234	—	60	5,443
20-23	9,207	679	296	120	71	—	670	11,043
20-24	6,429	555	200	2,068	265	60	286	9,863
20-25	2,169	704	300	637	456	55	505	4,826
21-23	1,475	70	220	13	—	—	140	1,918
21-24	4,064	175	55	5	—	—	—	4,299
21-25	4,661	715	200	981	155	10	370	7,090
22-24	3,261	20	298	305	120	—	55	4,059
22-25	3,276	193	330	1,857	189	—	20	5,865
Totals	41,408	4,462	2,479	8,770	4,332	140	3,217	64,808

CROPS—TULARE DISTRICT—1929

Tw.-Rg.	Alfalfa	Corn	Cotton	Vines	Misc. Or.	Truck	Ir. Grain	Total
S½ 19-23	2,059	180	1,110	248	131	5	240	3,973
S½ 19-24	2,954	636	1,508	617	492	10	375	6,592
S½ 19-25	2,799	579	877	875	1,770	—	—	6,900
20-23	8,750	742	2,042	20	32	—	20	11,606
20-24	5,027	754	1,923	1,364	143	253	10	9,474
20-25	2,486	720	1,990	267	291	33	225	6,010
21-23	1,553	140	378	—	—	—	30	2,101
21-24	3,369	228	1,828	—	—	—	517	5,942
21-25	3,380	235	4,220	307	53	—	230	8,425
22-24	470	30	5,570	210	31	—	75	6,386
22-25	1,187	95	4,525	1,282	60	—	80	7,229
Totals	35,034	4,339	25,971	5,190	3,003	301	1,800	74,638

CROPS IRRIGATED IN DELANO DISTRICT—1924

Tw.-Rg.	Alfalfa	Corn	Trk.	Ctn.	Vines	Ctrs.	Decid	Ttl.	KW Hrs. Consumed	Av. Pr.Ac.
22-24	342	5	20	254	5	—	12	638	350,164	558
22-25	515	40	—	126	365	—	60	1,106	612,505	555
22-26	167	40	—	40	170	—	—	417	168,361	404
2-234	545	—	—	5	80	—	—	630	502,554	798
23-25	1,897	393	103	499	1,711	—	118	4,721	3,340,288	708
23-26	66	100	12	140	712	—	90	1,120	511,917	457
24-25	814	441	298	320	4,147	—	423	6,443	3,996,909	621
24-26	233	427	272	1,183	3,548	50	227	5,940	5,105,914	860
24-27	—	10	—	—	74	756	60	900	1,204,160	1,336
25-25	1,046	202	247	390	1,860	—	35	3,780	2,814,355	745
25-26	216	120	350	305	3,777	457	348	5,573	5,836,158	1,045
25-27	—	25	—	—	15	55	5	100	121,140	1,211
26-25	1,310	—	135	—	195	—	—	1,640*	988,491	608
26-26	82	—	—	80	358	—	80	600*	329,273	550
*Totals	7,233	1,803	1,437	3,342	17,017	1,318	1,458	33,608	25,893,189	771

CROPS IRRIGATED IN DELANO DISTRICT—1929

Tw.-Rg.	Alfalfa	Corn	Trk.	Ctn.	Vines	Ctrs.	Decid	Ttl.	KW Hrs. Consumed	Av. Pr.Ac.
22-24	230	—	—	565	5	—	—	800	492,782	614
22-25	150	—	—	972	225	—	30	1,377	1,003,905	729
22-26	135	—	—	160	115	—	—	410	299,328	707
23-24	235	—	—	475	70	—	—	780	773,261	993
23-25	777	35	40	3,636	886	—	26	5,400	5,053,092	935
23-26	5	15	—	1,005	352	—	60	1,437	909,750	633
24-25	398	153	373	4,425	2,854	—	354	3,557	8,030,408	938
24-26	112	30	223	4,902	4,681	30	225	10,203	13,396,086	1,312
24-27	—	—	—	—	50	743	73	866	1,379,029	1,595
25-25	365	143	735	2,230	2,047	—	30	5,550	4,687,044	845
25-26	105	—	360	1,808	3,715	460	252	6,700	9,589,658	1,430
25-27	—	—	—	60	—	55	5	120	201,204	1,678
26-25	70	—	175	—	95	—	—	340*	360,558	1,060
26-26	40	—	—	535	358	—	80	1,013*	1,209,101	1,192
Totals	2,622	376	1,906	20,773	15,453	1,288	1,135	43,553	47,385,296	1,089

*The changes in total acreage in these Townships was due to division of the territory between the So. Cal. Edison Co. and the San Joaquin L. & P. Co. in 1925.

The irrigation of alfalfa for the feeding of dairy stock has for a great many years constituted one of the principal industries of the Tulare District and to a lesser extent of the Delano area. Such an industry requires a large population of steady, reliable people, permanently established with large investments in homes, cattle and permanent improvements, and means under ordinary conditions a community steadily growing in wealth with a dependable payroll each month.

Referring to these tables it will be noted that in the Tulare District the total alfalfa acreage has been reduced over 6,000 acres between 1924 and 1929 and that in the three southern townships this reduction has amounted to over 60%. At the same time there has been a marked increase in alfalfa acreage in township 19-25 where the water conditions are better and the cost of irrigation is still moderate.

Practically every other crop irrigated in 1929 was less than it was in 1924 with the single exception of cotton. Here we find an increase of ten fold, jumping from 2,479 acres in 1924 to 25,971 in 1929.

This increase in cotton acreage has not only overcome the loss in the other crops, but accounts for the 10,000 acre increase in the district as a whole.

In the Delano area we find a very similar condition in that the alfalfa acreage has reduced over 4,600 acres with a reduction in practically all of the other crops, and that cotton has here also accounted for the 10,000 acre increase that this district shows.

What is happening is plainly revealed by these tables, namely that alfalfa and the permanent crops adaptable to this area are being driven out by reason of the high cost of irrigation. Cotton, a temporary annual crop, under the stimulus of high prices that prevailed in 1926-27 has taken its place, and new land, under this same influence, has been put in cotton, still further aggravating the irrigation situation. This well illustrates the menace of the undeveloped lands to the water supply of the developed lands.

To give some further illustrations of the increasing power requirements with corresponding increase of costs we will refer to the conditions in Township 20 S. Rg. 23 E. and Tw. 20 S. Rg. 24 E. These Townships are in the heart of the Tulare District, where the permanent development has been the greatest and where, as a result, the ground water lowering has likewise been greatest.

The results in these Townships are given on the accompanying chart which shows the average Kilowatt hour consumption per acre irrigated from 1924 to 1929. This Chart shows the rapidly increasing rate of use of power, influenced more or less from year to year by the rainfall conditions. On this chart, the trend of increase has been projected forward to intersect the line which represents "1,000 Kilowatt hours per acre."

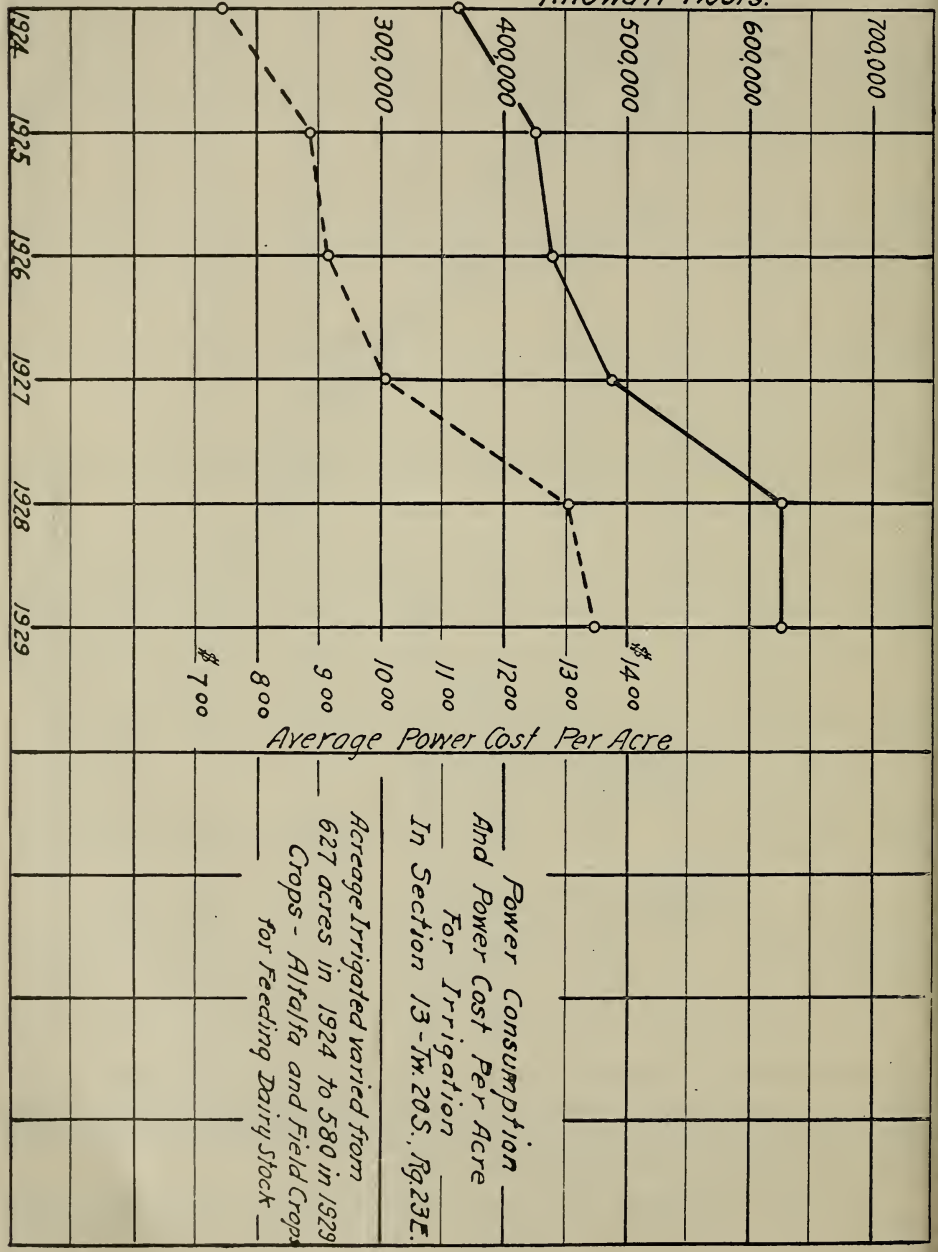
The thousand Kwhr. per acre is selected, as it is considered to represent the practical economic limit of use of energy and cost, for the average farmer for the class of crops now raised. It has been observed that only in the most favored areas is alfalfa being

irrigated on a commercial basis where the energy cost exceed this figure and that in some areas where the conditions are not so favorable the lessees of alfalfa lands and dairys look for other lands when the costs approach these figures.

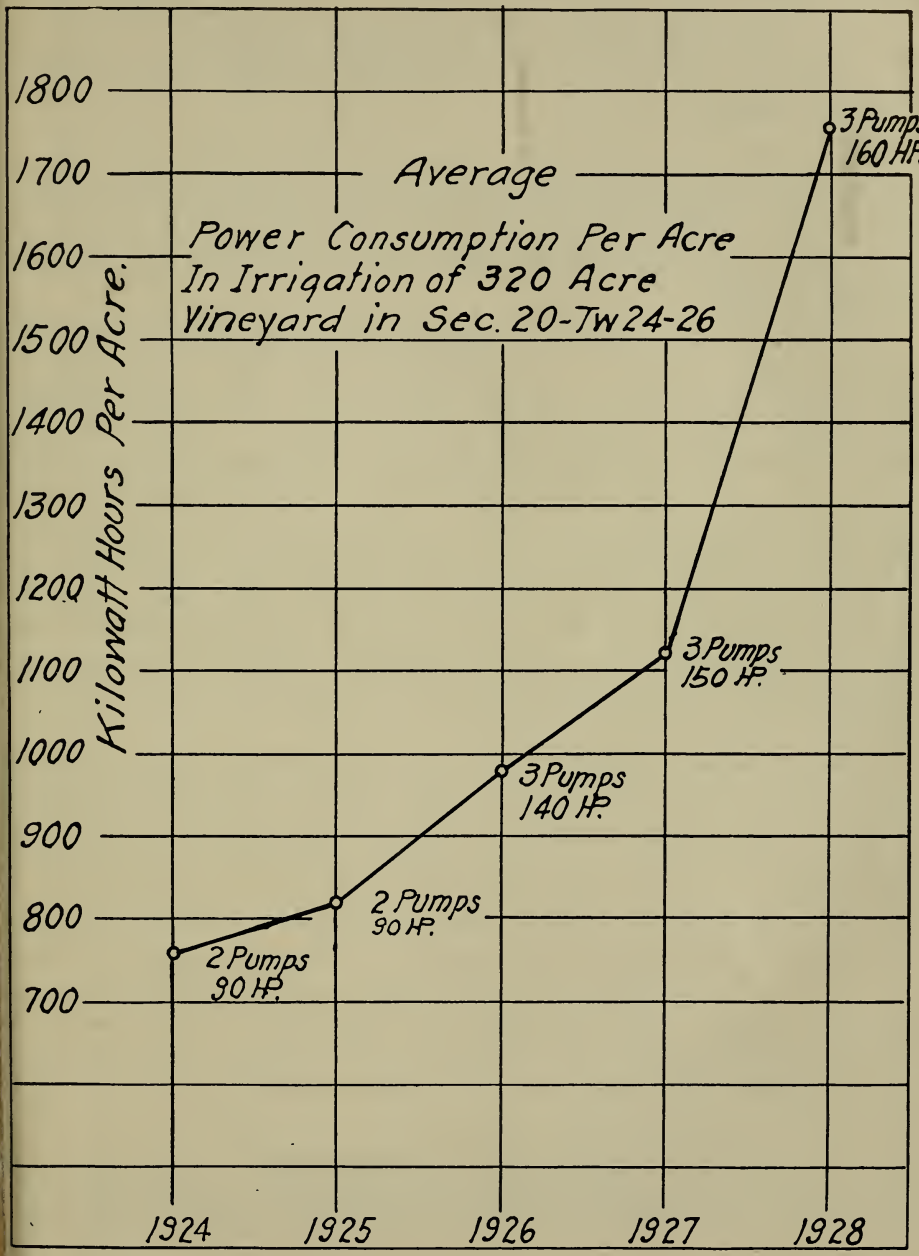
Within these two townships there is as yet only one section of land where the energy consumption has reached the 1,000 Kwhr. per acre. This is Sec. 13-20-23 and the con-

ditions in this section are illustrated by the chart attached.

The chart shows the steadily increasing requirements for power from 1924 while irrigating the same class of crops and practically the same acreage and shows an increase of about 70% in energy consumption within this period, with an increase in horse power connected, from 127 to 178 within that period.



One more illustration of the increasing use of energy for irrigation of the same crop and the same acreage is shown in the chart which shows the increasing use of energy and connected horse power for the irrigation of a 320-acre vineyard in the Delano district. Here the Kilowatt hours per acre jumped from 760 in 1924 to 1,760 in 1928, while the horse power required increased from 90 to 150.



Such illustrations of the increasing requirements for power and increasing cost of irrigation could be continued indefinitely and for every portion of Tulare County, but probably sufficient has already been shown to indicate the seriousness of this phase of the problem. Another phase of this same problem is the increasing capital investment required in order to provide water under this condition of constant lowering.

The conditions in the Tulare and Delano Districts of Southern California Edison Co. will again be used to illustrate this phase of the problem. In 1924 the total number of electric pumping plants in the Tulare District was 1,124 having a connected load of 12,034 horse power.

From 1924 to 1929 to keep up with the changing conditions, 636 of these pumping plants discarded the old pumping equipment and at the same time installed motors of larger capacity, the aggregate increase being from 6,300 H. P. to 9,976 H. P. During this period also, 225 of the original pumping plants having a load of 2,395 horse power were completely abandoned.

Thus during this short period 861 pumping plants, or 76½ per cent of the original number were either increased in size or abandoned. Where plants were abandoned, in most cases new plants of greater size were installed in new wells, meaning a complete new investment. Prior to 1924, practically all of the pumping in the Tulare District was by means of centrifugal pumps located in shallow pits. The wells were shallow, seldom exceeding 100 feet in depth, as the water-bearing strata within this depth yielded abundant water. With the lowering water plane, it was the custom to lower the pit and in many cases two or three such lowerings were made, until finally this expedient failed and the farmer was forced to install a deep well pump in a deeper well. There is no way of estimating the aggregate cost to the farmer of the successive temporary changes he makes before he is finally forced to make a complete change in his equipment, but this last change, involving as it does a new or deeper well and new and larger equipment can conservatively be estimated at $1,500 to $1,800 per plant.

A further disadvantage encountered, is, that it is found that the quantity of water a well will yield with a given draw down is much reduced. This means that additional wells are in many cases put in, in order to maintain the supply of water. Altogether the aggregate cost of the changes in equipment of old wells and of additional wells and equipment required to care for the acreage irrigated in 1924 amounts to not less than $1,500,000.00 in the Tulare District of Southern California Edison Co.. Many of the plants that were changed during the early part of the period have already been required to lower the pumps and install more horsepower. All of this points to the rapid depreciation of investment, and a conservative figure for this item alone would be for a life of six years in the area where the lowering is greatest or eight years for the district as a whole. The total charge off of interest, depreciation, taxes and maintenance should be not less than 25 per cent annually.

In the entire Tulare District of Southern California Edison Co. there were, at the end of 1929, a total of 1,485 electric pumping plants with a connected load of 22,590 H. P. With an average cost of $1,600.00 this would represent a total investment of $2,376,000.00.

The annual charge-off on this investment would amount to $594,000.00, which is about 48 per cent of the total cost, including energy charge.

In the Delano area we find similar conditions:

In 1924 there were 627 pumping plants having a connected load of 10,402 horse power.

From 1924 to 1929:

337 plants were increased from 4,931 H. P. to 7,543 H. P.

120 plants were abandoned.

Thus 72½ per cent of the original plants were changed or abandoned.

The cost of changes in this area are much greater than in the Tulare area, for the reason that wells are from 350 to 500 or 600 feet deep with some of them more than 1,000 feet. The equipment is also larger in size. An average of $2,500.00 per plant would not be an excessive estimate of the cost in changing the 450 or more plants involved. This would represent an investment of $1,125,000.00. The new plants that have been put in since 1924 are of large size, averaging 42 H. P. in motor capacity, with deep wells. The average cost of these would be about $4,000.00.

There were 163 new plants installed from 1924-29. Altogether, the aggregate investment in the 730 pumping plants in the Delano District at the end of 1929 is estimated at $2,000,000. The carrying charge on this investment would be about $500,000.00 annually, which is about 47½% of the total cost including power charge.

The foregoing figures indicate that the total average annual cost per acre for energy and carrying charge on plant is about $16.50 per acre in the Tulare District and $24.00 per acre in the Delano District. These are average figures and based on the cost of 1929, which were the highest of the six years considered. Whether the average farmer will be able to carry this load has yet to be demonstrated, but it has already been proven that the average alfalfa grower, feeding dairy stock begins to look elsewhere when the water cost exceeds in any appreciable amount the average figure now set for Tulare. The limit for the cotton grower has not been established, but it is probable that this limit has already been reached in the Delano area except under the most favored conditions and large crop yields. This is proven by the fact that some of the large operators in cotton in that district are reducing their cotton plantings in those areas where the cost of pumping is the greatest.

It is quite certain in any event that the trend of costs which are ever upward will soon reach such a figure that a large part of the farmers in each of these districts will be compelled to cease pumping, not only on account of the operating costs, but on account of their inability to finance further investments in pumping equipment.

In each of the other districts of Tulare County, centering at Visalia, Lindsay and Porterville, there is a repetition of the story that has just been given for Tulare and Delano. We find an increasing number of pumping plants being changed with greater horse power installed, pumping plants abandoned and additional plants installed to care for the same acreage. The aggregate cost of all of these changes during the last five years runs into a staggering total. We also find that the Kilowatt hours per acre irrigated is increasing at about the same rate as was shown in detail for Tulare and Delano, that is from 40 to 50 per cent.

It is estimated that on account of the lowering water between 1924 and 1929, the excess of power that was used in 1929 over what would have been used had 1924 conditions continued, amounts to 56,000,000 Kilowatt hours which cost the irrigators about $670,000.00 in these other three districts of Tulare County.

ABANDONED LANDS

The crop survey of Tulare County for 1929 showed a total of 10,012 acres of orchards and vineyards abandoned.

These abandonments should probably be classified under the following heads:

(1) Due to an actual shortage of water.

(2) Due to inability to finance further pump changes.

(3) Due to crop failures and low prices in which water costs are not involved.

It is impossible to know the conditions involved in each abandonment, but there are certain areas in which the abandonments are due directly to a lack of water. The total of such abandonments in the County amounts to 3,000 acres of what was formerly high-class orchards. Examples of such abandonments are found in the East Orosi and Foothill Irrigation District area; the foothill orchards in Township 16 S., Rg. 26 E. And many orchards and vineyards in Township 22 South, Ranges 27 and 28 East, and Township 23 South, Ranges 27 and 28 East. Photographs of some of these abandoned orchards and vineyards are shown herein.

Many illustrations of the second class of abandonments are found scattered throughout the Tulare and Delano areas, where farmers have been forced to abandon lands on account of their inability to borrow more money to change their pumping plants. The acreage involved in this class is not known.

In addition to the abandoned orchards and vineyards which were noted in the 1929 Crop survey and just referred to, there are hundreds of acres in the Goshen, Tulare, Tipton, Pixley and Delano areas that were formerly in alfalfa or irrigated for pasture, which are now dry. Throughout this area there are numerous abandoned farms equipped with houses, barns and milking sheds, falling to pieces and completely deserted, entirely by reason of the cost of water or the expense of new equipment for obtaining it.

Had it not been for the fact that cotton has been grown on some of these abandoned farms during the last two or three years, it is literally true that some of the townships would now be practically deserted, and this in a territory that was formerly a prosperous dairying country.

When cotton has exhausted the stored up fertility of these old alfalfa fields, it too, will abandon these areas and they will revert to their original unused conditions, for alfalfa or other field crops will not again be put in.

The reduction in alfalfa acreage has already been referred to. It will continue to reduce in these areas, and at a greater rate.

To give a better conception of the extent of the area in Tulare County in which the lowering ground water is threatening the life of the alfalfa and dairying industry, two companion maps have been prepared to show the changing conditions in various years.

The first of these maps shows the depth to ground water throughout the area in the

Fall of 1921. On this map the shaded portion shows the areas where the ground water was at a depth of 45 feet or more.

The depth of 45 feet is chosen, since at from 40 to 50 feet is the depth marking the dividing zone for the farmer between retaining his old centrifugal pump in a pit, and going to the expense of installing a deep well outfit.

To follow the lowering ground water to this depth, he has already lowered his centrifugal pump, in three or four successive stages, but ordinarily any further lowering is not practicable, so he is faced with the necessity of installing a deep well pump which means a 90% loss of his original investment and a 200 to 250% new investment. This step marks the beginning of the troubles of the alfalfa grower, so the depth of 45 feet is an appropriate one as marking the outer limits of a danger area.

It will be seen that the shaded area, on the 1921 map was mostly confined to the foothill belt where alfalfa never has been a commercial crop; to parts of the Delano and Earlimart areas, and to a small island containing a few sections, between Tipton and Pixley. In the rest of the County, which embraces the principal portion of the irrigated area, there was no spot where the ground water was anywhere near the danger depts which we have set.

On the companion map is shown the limits of the danger area for the years 1925, 1927 and 1929.

This map clearly shows how rapidly this danger area is spreading; how there has been a spread from various centers of pumping to merge with the depressed areas of the others until finally there are only narrow areas in the Kaweah and Tule River deltas in which the depth to ground water has not yet reached the danger point. The seriousness of this situation is hardly appreciated even by our own people.

EFFECT ON LAND VALUES OF LOWERING WATER PLANE

In an area such as Tulare County where irrigation has to be done by pumping, it is literally true that every foot of lowering depreciates the intrinsic value of the land for crop purposes by a certain amount. Furthermore this depreciation of value does not follow a straight line formula, but a curve of increasing divergence, for the lower the ground water drops the costs increase at a greater rate.

The capitalized value of the increased operating cost and the interest and depreciation on the investment in additional equipment required for pumping, fairly represents the loss in intrinsic value of the land for a given crop purpose.

As alfalfa is the principal crop raised within the valley portion of Tulare County, it is interesting to calculate the losses in value that have, and are occurring by reason of this lowering.

Assuming that the annual quantity pumped per acre is 4 acre feet, the additional cost of each 10 feet of lowering of ground water would be made up of the cost of the additional amount of energy required—or 100 kilowatt hours costing $1.20, and the additional depreciation the plant would suffer by reason of its shortened life. This would depend upon the rate at which the water lowered and might amount to an additional $1.00 per acre or more.

Thus the direct cost for each 10 feet of lowering would amount to $2.20 per acre. Capitalizing this on a 7% basis, would mean an actual loss in value of the land of $30.00 per acre.

As the pumping plant investment must be doubled after the ground water reaches the 45 to 50-foot level, there is a corresponding increase on the carrying charge on the capital involved, so that a $30.00 loss of land value for each 10 feet of lowering is moderate. As certain areas are now showing a loss of from 6 to 8 feet per year, the intrinsic loss of our land values in the aggregate is greater than the net income from the crops produced.

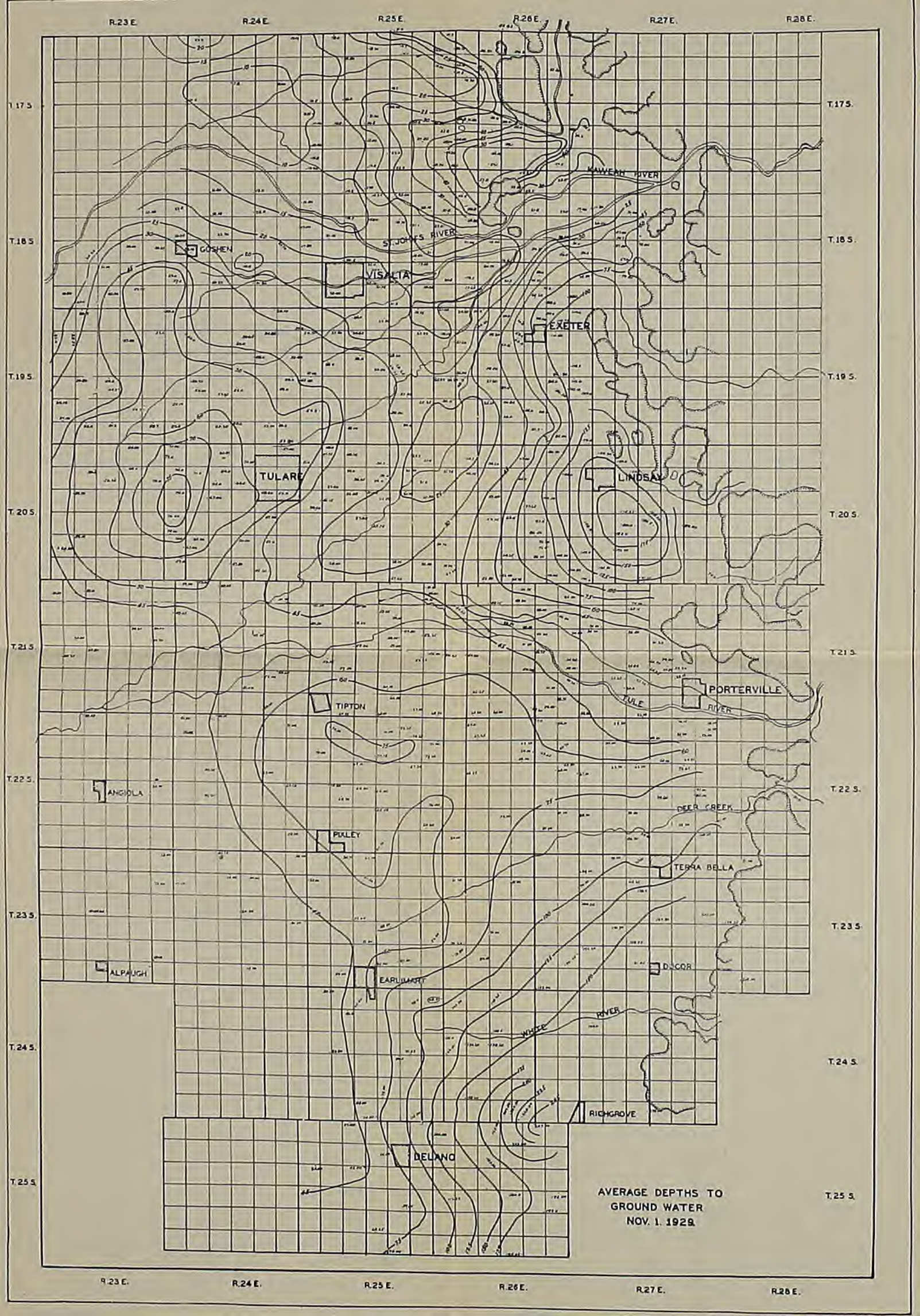
The dropping water levels in some districts eventuate in other troubles besides shortage of supply. In the Lindsay-Strathmore Irrigation District, one of the finest citrus areas in California, it was found that when the ground water reached certain levels it was so impregnated with salt as to be ruinous if applied to the land.

A thoroughly established legal right, and the means of asserting it, aggravate the situation in Tulare County and in fact in all the Southern Valley Counties. That right is the right of every landowner to pump all water necessary for use on his land from beneath the surface thereof. There is no way to stop individual development. So long as any hope for returns remains, the owners of undeveloped lands will continue to develop them and every ne wpump which goes in for use on new land makes the situation worse. In Tulare County there are 633,486 acres of No. 1 land by recent state classification and 190,834 acres of No. 2 lands, or a total in these two classes of 824,320 acres. In 1929, a crop survey showed 316,943 acres of this irrigated, or less than 40 per cent. The undeveloped lands with their right in the waters beneath constitute therefore a great menace to the developed lands around them.

We can not close as to Tulare County, without presenting the following statistics concerning it:

Population (1930 census), 75,740.
Population (1920 census), 59,031.
Total assessed valuation, $97,254,548.00.
Sale value of 1929 agricultural products, including cattle, hogs, wool, dairy products, poultry and poultry products, $35,664,520.00.
Number of farms (estimated), 8,000.
Total acreage No. 1 lands (State classification), 633,486.
Total acreage No. 2 lands (State classification), 190,834.
Total enrollment in public schools, 22,430.
Average annual rainfall varies from 6 to 11 inches, depending on locality.

The wealth and annual productive power of this great county evidenced by the foregoing figures will in large part be lost unless relief by way of an additional supply of water is afforded to it. We think that we have herein abundantly demonstrated that this great disaster now actually threatens Tulare County, and certainly the situation is such, in view of the threatened loss and destruction of property, as well as the human suffering that will be involved, to call for not only the interest and concern of the remainder of the state but of the nation itself.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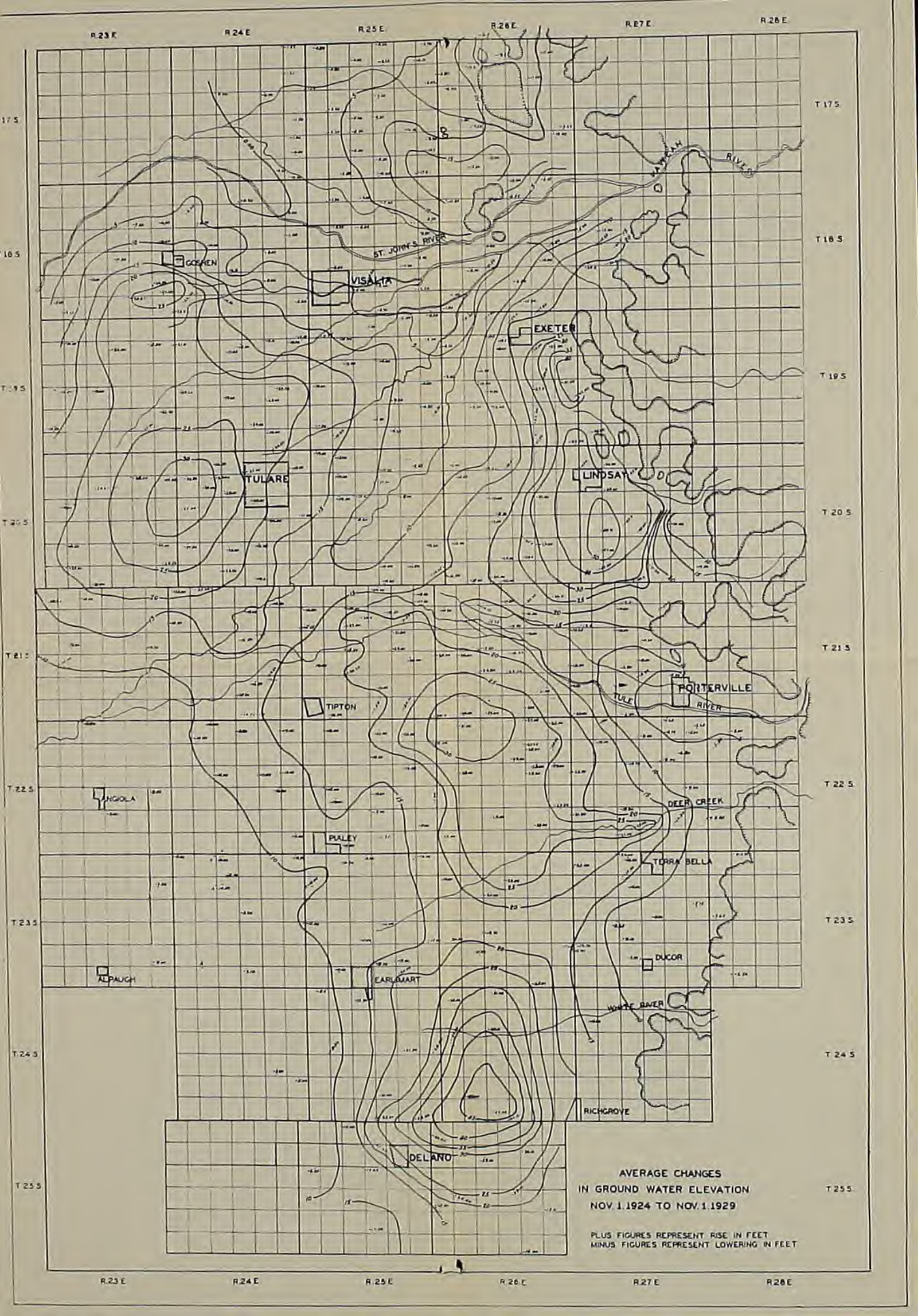
ST. JOHNS RIVER
GOSHEN
VISALIA
EXETER
TULARE
LINDSAY
PORTERVILLE
TULE RIVER
TIPTON
ANGIOLA
PIXLEY
DEER CREEK
TERRA BELLA
ALPAUGH
EARLIMART
DELANO
RICHGROVE
WHITE RIVER
AVERAGE DEPTHS TO GROUND WATER NOV. 1. 1929.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TIPTON
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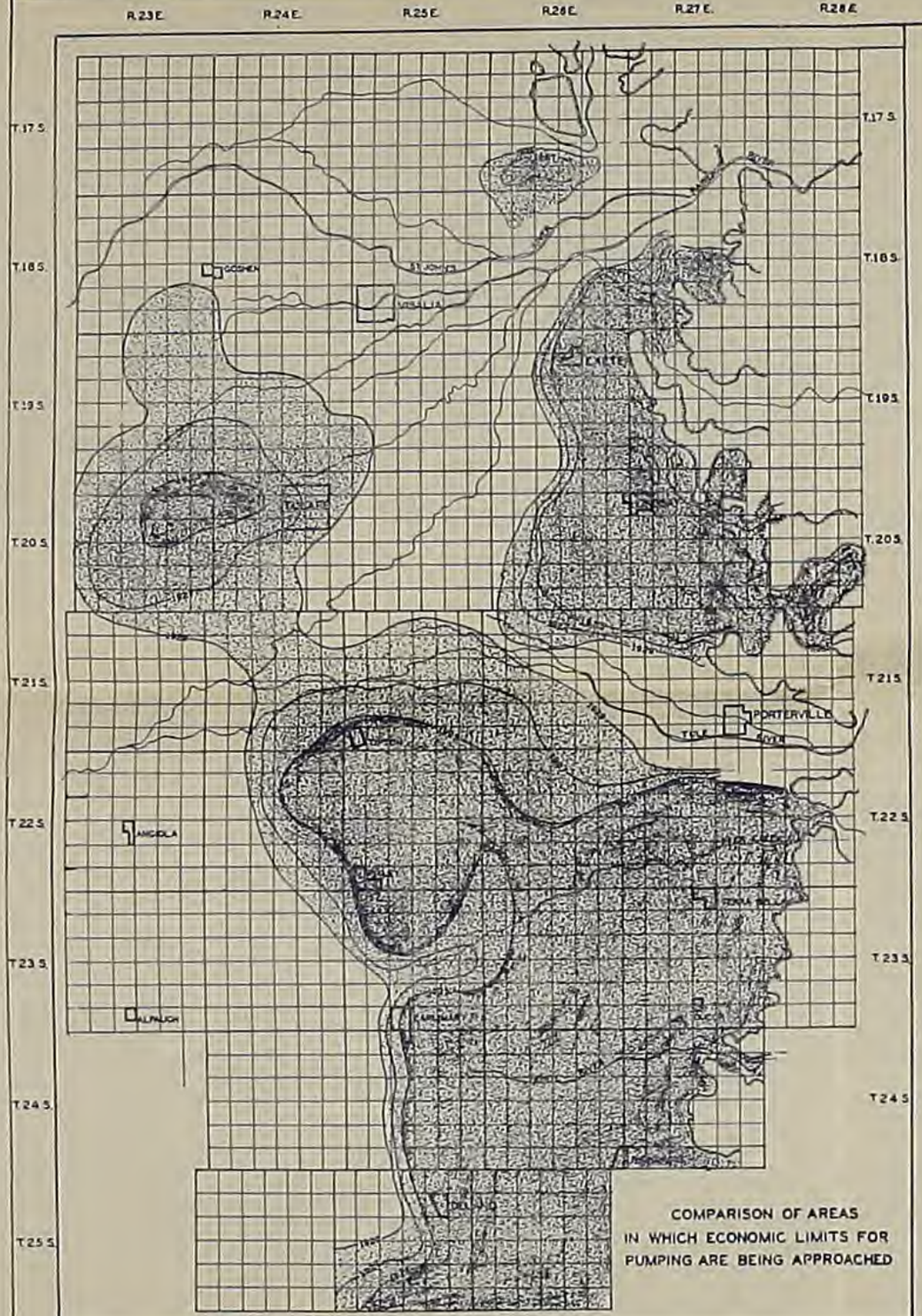
TULE RIVER
DEER CREEK
PIXLEY
TERRA BELLA
DUCOR
EARLIMART
WHITE RIVER
RICHGROVE
DELANO
ALPAUGH
AVERAGE CHANGES
IN GROUND WATER ELEVATION
NOV. 1, 1924 TO NOV. 1, 1929
PLUS FIGURES REPRESENT RISE IN FEET
MINUS FIGURES REPRESENT LOWERING IN FEET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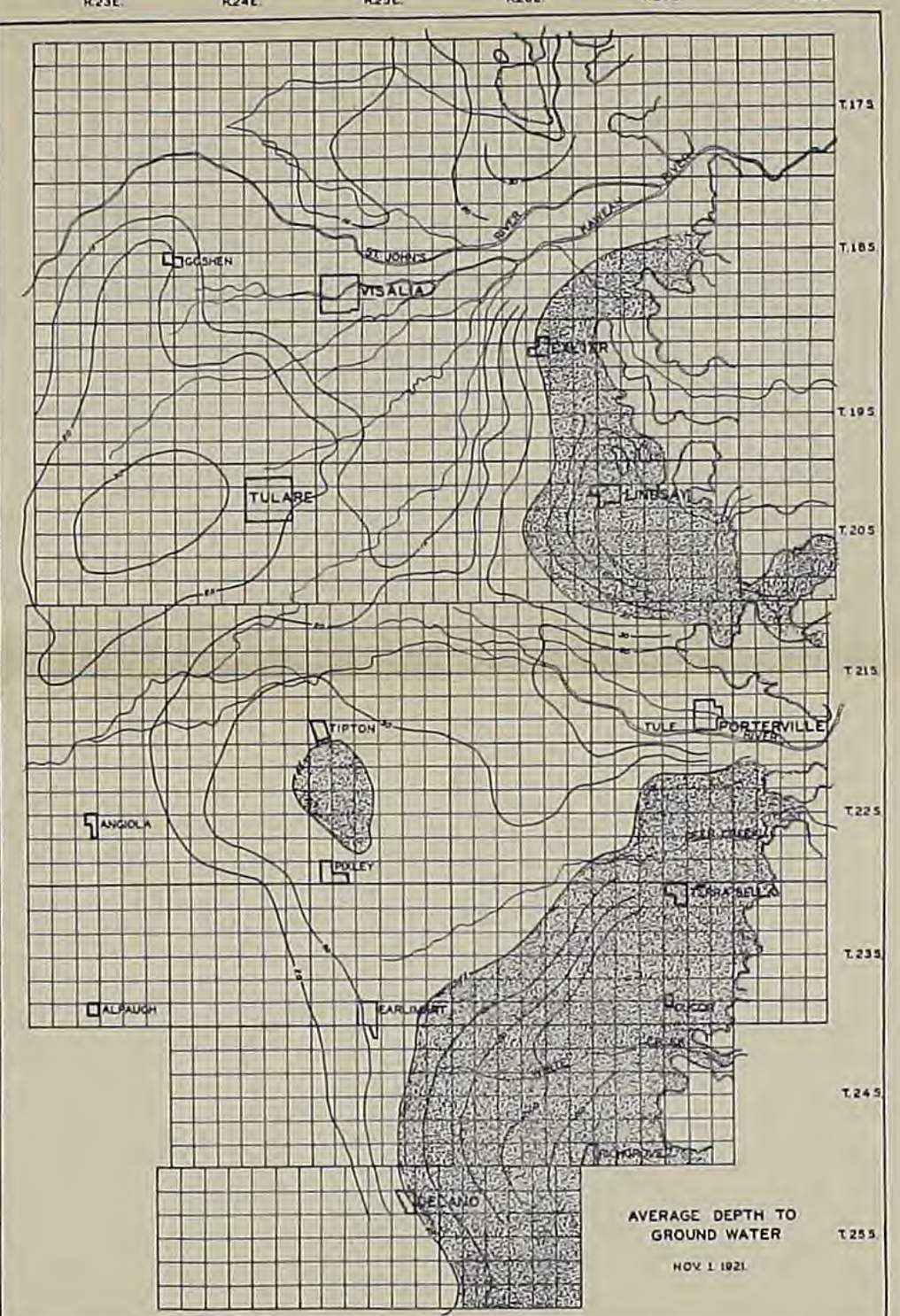
GOSHEN
VISALIA
EXETER
TULARE
PORTERVILLE
ANGIOLA
POLEY
ALPAUGH
COMPARISON OF AREAS
IN WHICH ECONOMIC LIMITS FOR
PUMPING ARE BEING APPROACHED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